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Taxation and Supplier Networks: Evidence from India*

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Abstract

Do tax systems distort firm-to-firm trade? This paper considers the effect of tax policy on supplier networks in a large developing economy, the state of West Bengal in India. Using administrative panel data on firms, including transaction data for 4.8 million supplier-client pairs, we first document substantial segmentation of supply chains between firms paying Value-Added Taxes (VAT) and non-VAT-paying firms. We then develop a model of firms' sourcing and tax decisions within supply chains to understand the mechanisms through which tax policy interacts with supply networks. The model predicts partial segmentation in equilibrium because of both supply-chain distortions (taxes affect how much firms trade with each other) and strategic complementarities in firms' tax choices. Finally, we test the model's predictions using variations over time within-firm and within supplier-client pairs. We find that the tax system distorts firms' sourcing decisions, and suggestive evidence of strategic complementarities in firms' tax choices within supplier networks.

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1 Introduction

Intra-national trade costs are large in developing countries and gains from better integration of supply chains within these countries are potentially substantial (WTO, 2004). Whilst the role of geography as a determinant of such costs is well established (see for example Atkin and Donaldson, 2015), tax policy can also play a role because most tax systems alter the incentives agents have to trade with each other (Fajgelbaum et al., 2019). This is true in particular of the Value-Added Tax (VAT), one of the largest source of revenues in developing countries (Bird and Gendron, 2007), as only VAT-paying firms can deduct VAT paid on their purchases from their tax liabilities. The tax system thus potentially distorts firm-to-firm trade in markets where VAT and non-VAT-paying firms co-exist – a pervasive feature of developing countries – leading to segmentation of supplier networks between firms that pay VAT and firms that don't.

This paper considers two related questions. First, how does the tax system affect firms' sourcing decisions, and therefore firm-to-firm trade, in a large developing economy? Second, how do supplier networks affect firms' tax decisions, in particular the decision of whether or not to pay VAT? We build a model of firms' sourcing and tax decisions to understand the mechanisms through which tax policy interacts with supplier networks. We then test the predictions of our model using a rich panel dataset including firm-to-firm transactions for the state of West Bengal in India. We find both that the tax system distorts trade and that there are strategic complementarities in firms' tax decisions within supplier networks.

Our first contribution is to document the segmentation of supplier networks between firms with different tax status (VAT-paying and non-VAT-paying firms) in our context. A key constraint faced by the literature on intra-national trade is that domestic trade flows are hard to characterize because firm-to-firm trade is rarely observed[1]; similarly administrative tax data typically does not contain information on agents with different tax status. We overcome both these observational challenges by using administrative tax data on the universe of the 180,000 firms paying taxes in West Bengal for the period 2010-2016, and two particularities of our context. First, we observe both VAT-paying and non-VAT-paying firms because firms below a size threshold can opt for a non-VAT 'simplified' tax status, under which they pay a small tax on their sales but cannot deduct VAT paid on their purchases from their tax liabilities. Second, we observe trade between 4.8 million annual client-supplier pairs, be-

[1]Exceptions include Atalay et al. (2011); Bernard et al. (2015); Carvalho et al. (2016); Tintelnot et al. (2018) who use firm-to-firm trade data for the US, Japan and Belgium. We discuss our contribution to this literature below.

cause VAT-paying firms report transactions with other tax-registered firms. This allows us to map supplier networks by matching clients' and suppliers' tax identifiers.[2]

We find that VAT-paying firms are substantially more likely than non-VAT-paying firms to trade with other VAT-paying firms. The correlation between firms' tax status and how much they buy from, or sell to, VAT-paying firms is large and robust to controlling for detailed location and industry characteristics and holds for firms of all sizes. VAT-paying firms on average sell 13% more to VAT clients, and buy 9% more from VAT suppliers, all else equal, than non-VAT-paying firms, in line with the idea that the VAT system leads to partial segmentation of supplier networks by tax status.

Our second contribution lies in a model that clarifies the mechanisms leading to the supply chain segmentation we observe. The model is a bi-partite application of models of supplier networks (see for example Tintelnot et al., 2018), augmented to include a tax status choice decision: whether or not to pay VAT. Our set-up is one in which firms at two stages in supply chains simultaneously take tax and sourcing decisions under monopolistic competition. Our main result is that under a VAT system there is partial segmentation of supply chains by tax status in equilibrium, for two reasons. First, the VAT's incentive structure leads to *supply-chain distortions*: all else equal a VAT-paying firm buys a higher share of its inputs from VAT-paying suppliers than a non-VAT-paying one does. This mechanism implies that the VAT decreases trade between firms with different tax status, even in a world where firms' tax status are exogenously given. Endogenising firms' tax status choices introduces a second mechanism, *strategic complementarities in tax decisions*: firms are more likely to choose to pay VAT the more they trade with VAT-paying suppliers and clients.

Finally, our third contribution is to provide empirical evidence on the mechanisms outlined by our model. We first estimate the causal effect of taxes on firm-to-firm trade (supply chain distortions) and then the causal effect of the tax decisions of a firm's trading partners on its own tax decisions (strategic complementarities). We identify this effect by leveraging our transaction level data and within supplier-client pairs variations in trade over time, allowing for supplier-specific unobserved productivity shocks. We find that firms buy 12% more on average from VAT-paying suppliers when they themselves choose to pay VAT. Our estimates imply a trade elasticity between 4 and 7, within the range of estimates obtained in the international trade literature (Caliendo and Parro, 2015; Bartelme et al., 2018).

To identify strategic complementarities in firms' tax status decision we use within-firm changes over time in the share of sales (inputs) that firms can sell to VAT-paying clients

[2] Alfaro-Urea et al. (2018) use similar administrative data on firm-to-firm transactions for Costa Rica to consider the effect of joining multinational supply chains on firm productivity.

(purchase from VAT-paying suppliers) generated by the entry and exit of VAT-paying trading partners. We find evidence of strategic complementarities in tax status choice: our estimates imply that forcing all of a firm's trading partners to pay the VAT would increase that firm's propensity to pay the VAT by 5-8 percentage points compared to a situation where none of its trading partners pay VAT. These results are robust to controlling for location– and product– specific shocks that could explain both firm entry and changes in tax status choice, and to controlling for firm size. Simulation exercises using our estimates show that the two mechanisms explain a non-trivial share of the supply chain segmentation by tax status we observe.

A large literature has considered how taxes affect international trade flows (see Goldberg and Pavcnik, 2016, for a review on the role of tariffs), but there is limited evidence regarding how taxes determine intra-national trade – one exception is Fajgelbaum et al. (2019) who show that state taxes affect the spatial allocation of economic activity in the US.[3] To the best of our knowledge this paper is the first to show how the tax system shapes intra-national firm-to-firm trade. Our results more generally contribute to the recent literature that considers the role of intra-national trade costs (Agnosteva et al., 2014; Atkin and Donaldson, 2015; Cosar and Fajgelbaum, 2016; Fajgelbaum and Redding, 2018) by showing that the tax system affects these costs and therefore firms' sourcing decisions. This paper also speaks to the large literature on firms in developing countries that studies the role of market frictions in the formation of client-supplier relationships, and finds that enforcement and information constraints loom large in this context (McMillan and Woodruff, 1999; Banerjee and Duflo, 2000; Allen, 2014; Macchiavello and Morjaria, 2015). Unlike much of this literature, which studies relationships between multinational companies and their suppliers in developing countries, we focus on within-country trading relationships. We find that whilst frictions may also be substantial in our context they do not lead to a low willingness of firms to substitute across suppliers in response to changes in relative input costs.

Our results also contribute to the literature on public finance in developing countries that asks how the particular context of these countries changes tax policy trade-offs (Boadway and Sato, 2009; Gordon and Li, 2009; Best et al., 2015; Bachas and Soto, 2017; Carrillo et al., 2017; Cage and Gadenne, 2018; Jensen, 2019). We focus on how the VAT affects supply chains when VAT-paying and non-VAT-paying firms co-exist within markets, a pervasive feature of the developing country context. The literature on the VAT typically argues this tax is better suited than Retail Sales Taxes to contexts in which compliance is low, because it generates a third-party reported trail on transactions between firms (Pomeranz, 2015; Nar-

[3]See also Benzarti et al. (2018) for evidence regarding the role of domestic taxes in international trade.

itomi, 2018).[4] Our innovation is to show that this compliance advantage must be weighted against the efficiency cost due to supply chain distortions, distortions that would not occur under Retail Sales Taxes, and provide empirical evidence regarding the magnitude of these tax-induced distortions.[5] The idea of strategic complementarities in tax choices under a VAT was first introduced by De Paula and Scheinkman (2010); we build on their work by incorporating tax decisions in a supplier network model and providing causal evidence of the existence of these complementarities. Evidence in line with the existence of complementarities in tax choices is also found in Almunia et al. (2017) who show that higher input use increases the probability that firms choose to voluntarily register to pay VAT in the UK.

Finally, this paper also speaks to the growing literature on supplier networks that leverages new datasets on firm-to-firm transactions to characterize the determinants of supplier networks and the propagation of shocks within these networks (Atalay et al., 2011; Bernard et al., 2015; Acemoglu et al., 2016; Carvalho et al., 2016; Bernard and Moxnes, 2018; Tintelnot et al., 2018; Di Giovanni et al., 2018; Boehm and Oberfield, 2018; Liu, 2018; Dhyne et al., 2019). Using data for India we contribute to this literature in two ways. First, we consider theoretically, and provide empirical evidence on, the role of the tax system in shaping supplier networks. Second, we show that firms' decisions are linked within these networks through strategic complementarities in tax choices. Our results imply that shocks to the tax system will propagate through supplier networks: an enforcement policy that induces some firms to start paying VAT will have multiplier effects as others in these firms' supply chains will also start paying VAT.

The paper is organized as follows. Section 2 describes our context of study and data and provides descriptive evidence on segmentation of supplier networks. Section 3 develops a model of firms' sourcing and tax status decisions and Section 4 discusses the empirical strategy used to provide causal evidence on the model's mechanisms. Section 5 presents our results and discusses their implications for policy.

[4] See also Emran and Stiglitz (2005), Keen (2008) for theoretical work regarding the optimal tax policy mix in the presence of informal sectors.

[5] In an independently developed project Gerard et al. (2018) study a similar question in the context of the state of Sao Paulo, Brazil.

2 Context and data

2.1 Institutional background

Our context of study is West Bengal, a large state in the East of India with 90 million inhabitants which accounts for 7% of the country's GDP. Our period of study is 2010-2016. The main source of tax revenues at the state level is the value-added-tax (VAT). All firms with a turnover of more than 500,000 INR (7,100 USD) are required to remit taxes to the state. Firms with a turnover of less than 5 million INR (70% of tax-registered firms) can opt to remit taxes under a 'simplified' tax scheme under which they only pay a 0.025% tax on their total sales. Importantly for the purpose of this paper, firms in the simplified scheme cannot deduct taxes paid by their suppliers from their tax liabilities. All other firms must remit the VAT, and can deduct VAT paid on their inputs by their suppliers from their tax liabilities. In addition most firms are liable to pay Corporate Income Tax (CIT) to the federal government. The CIT liability is not affected by the VAT liability, does not change at the 5 million INR threshold, and the state and federal governments did not share information about taxpayers during our period of study (see Nandi and Gosh, 2017, for more details on West Bengal's tax system).

Firms face different VAT rates depending on the goods they sell: 75% of them sell goods belonging to the 'reduced' tax schedule and taxed at 4% , 21% sell goods in the 'main' tax schedule taxed at 12.5%, whilst the remainder of firms face super-reduced rates of 0% or 1%. In fiscal year 2014 the VAT rates of the main and reduced schedules increased by 1 percentage point. India's VAT system changed substantially with the introduction of the General Sales Tax reform in 2017, after our period of study. We discuss what our results imply for the potential impact of this wide-ranging reform below.

2.2 Data

2.2.1 Firm data

We use administrative data on firm-level tax returns and tax registration information from the Directorate for Commercial Taxes of the state of West Bengal, India, for the fiscal years 2010-2011 to 2015-2016. This dataset contains the annual tax returns of the nearly 180,000 firms paying taxes to the state over the period, whether in the VAT or the simplified scheme. Firms paying taxes under the VAT scheme report their total sales, total input purchases, and VAT paid on these inputs, if any. The latter gives rise to an 'input tax credit' which is deducted from the total taxes due on sales. Firms paying taxes under the simplified

scheme report their total sales and total input purchases. In addition to the variables used to compute their tax liabilities firm must report the main product they sell, we use this information to allocate firms to one of 170 product categories and a VAT tax schedule. We obtain information on firms' location from their postcode in the tax registration data. Our sample contains 818,865 observations at the firm-year level for 178,011 firms over 6 years .

2.2.2 Trade data

Firms in the VAT scheme are required to report to the tax authorities all transactions with other firms registered to pay taxes in West Bengal, regardless of whether the trading partner is in the VAT or the simplified scheme.[6] They report the annual transaction amount as well as the tax identification number of the client or supplier involved in the transaction in the 'Annexure B' part of their tax returns, which has been made available to us. Firms in the simplified scheme do not report transactions to the tax authorities, so we do not observe trade between firms in the simplified scheme.

Transactions between VAT-paying firms must be reported by both parties in the transaction. These two parties have no incentive to collude (a transaction increases the tax liability of the supplier, but decreases the tax liability of the client) and tax authorities systematically cross-check amounts reported by the two parties involved. Transactions between VAT-paying firms and non-VAT-paying firms in the simplified scheme however are only reported by VAT-paying firms, so they cannot be cross-checked against third-party information. VAT-paying firms have an incentive to report purchases from non-VAT-paying suppliers truthfully: these do not affect their tax liabilities, but all types of mis-reporting lead to fines if detected through a tax audit regardless of their impact on tax liabilities. Firms can similarly expect to be penalized if they mis-report sales to non-VAT-paying clients, but these sales can potentially increase their tax liabilities. If firms only report sales that the tax authorities have third-party reported information on, under-reporting of sales to clients in the simplified scheme is a potential concern.

Several pieces of evidence suggest that in practice under-reporting by VAT-paying firms of sales to firms in the simplified scheme is unlikely to be a major concern; this evidence is presented in Appendix B.2. First, we find that firms are not less likely to report sales to non-VAT clients than purchases from non-VAT suppliers, despite the fact that only sales can potentially increase their tax liabilities. On the contrary, firms are a lot more likely to

[6] Firms do not have to report a trading partner if its annual trade with this partner is less than 50,000 INR (710 USD).

report a client in the simplified scheme than to report a supplier in the simplified scheme.[7] Second, we decompose firms' sales into 'third-party-reported sales' (sales to VAT clients) and 'voluntarily reported sales' (all remaining sales, including those to final consumers). Declaring sales to clients in the simplified scheme only increases firms' tax liabilities if these sales are larger than the 'voluntarily reported sales' that firms report regardless. We find that firms report total sales that are much larger than their third-party-reported sales: third-party reported sales represent only 30% of total sales on average. Reporting non-VAT clients truthfully will thus not increase the liabilities of the average firm. Third, we find that the share of third-party reported sales is not positively correlated with the share of sales to clients in the simplified scheme, contrary to what we would see if only firms with a large 'voluntarily reported sales' share were willing to truthfully report sales to these clients.

Overall our data contains information for 4.8 million annual supplier-client pairs. Combining this transaction data with the firm data allows us to observe, for each firm in each year, its VAT-paying clients and suppliers and how much it sells to, and buys from, VAT-paying firms.

2.3 Descriptive statistics

Table 1 presents the key characteristics of firms in our data. The first column includes all firms in the simplified scheme, the second column all firms in the VAT scheme but with a turnover under 5 million INR (and therefore eligible to choose the simplified scheme) and the last all remaining VAT firms. Less than one-third are in the capital region Kolkata, though this share increases amongst larger firms. Appendix Figure B.1 plots the location of the firms in our data on a map; there are firms paying taxes under both tax schemes in all regions in the state. Looking at firm size (turnover) we see that most firms (70%) have a turnover of less than 5 million and are therefore eligible to choose between the VAT and simplified schemes. Among those the majority (85%) choose to pay taxes under the VAT scheme. The detailed distribution of firm size by tax status, presented in Appendix Figure B.2, however shows a substantial amount of bunching below the 5 million threshold for firms in the simplified scheme, suggesting some firms have a high preference for this scheme that leads them to produce less (or report less sales) to avoid paying VAT.

The remaining lines of Table 1 show that firms in the simplified scheme sell a much smaller share of their sales to VAT-paying clients (1%) compared to similar-sized firms in the VAT scheme (28%). The share of intermediate inputs purchased from VAT-paying suppliers is

[7] We find that 6% of VAT firms report at least one non-VAT client, less than 1% report a non-VAT supplier. See also Table 1 below.

similarly lower for these firms than for VAT-paying firms. Even when firms in the simplified scheme do trade with VAT-paying firms, they have less VAT-paying clients and suppliers then VAT-paying firms of similar size (last two lines of Table 1). Figure 1 plots trade with VAT-paying firms as a function of firm size separately for firms in different tax schemes. We see that VAT-paying firms trade more with other VAT-paying firms than firms in the simplified scheme at all points of the size distribution below the 5 million threshold.

Table 1 and Figure 1 provide evidence of partial segmentation of supply chains by tax status: VAT-paying firms are more likely to trade with VAT-paying firms than firms in the simplified scheme. This could be due to different characteristics of VAT- and non-VAT-paying firms, unrelated to their tax status, that lead them to choose not to trade with each other. Table 2 assesses whether this is the case by considering the correlations between a firm's own tax status (a variable equal to 1 if the firm is in the VAT scheme, 0 otherwise) and the share of its sales (intermediate inputs) that is sold to (purchased from) VAT firms, controlling flexibly for firm characteristics that affect their position in supply chains: the products they sell and their location. We restrict the sample to firms which are eligible to choose their tax status; to allow for the possibility that firms could choose to produce more than 5 million whilst in the VAT scheme and bunch at the 5 million threshold whilst in the simplified scheme we consider all firms with a minimum turnover over the period of less than 7 million INR. We find that up to 40% of the correlation between firms' choice of tax scheme and how much they sell to VAT clients can be explained by firms in different tax schemes selling different products (column 2) and/or being in different locations (columns 3 and 4), though the correlation between tax status and purchases from VAT suppliers is unaffected by controls. The correlations remains large and statistically significant when controlling for all firm characteristics. Overall we find that, all else equal, VAT-paying firms sell 13% more to, and buy 9% more from, other VAT-paying firms than non-VAT-paying firms.

The types of products sold by firms in 2010-2011 are presented in Appendix Table B.1. Over one-fourth of tax-registered firms in West Bengal sell machines or construction materials, other commonly sold categories are electrical and electronic goods, food, chemical products, and textiles. The share of VAT-paying firms among firms eligible to choose the simplified scheme is highest for products often used as intermediate inputs (machines, metal product and mining) and lowest for products more commonly sold to households (household goods, textiles and food). This is in line with the idea that firms selling to non-VAT-paying clients are less likely to choose to be in the VAT scheme, and explains why product fixed effects decrease the correlations in Table 1.

3 Model

We model an economy in which two different types of firms, upstream and downstream, take sourcing and tax decisions to maximize their profits. Upstream firms produce using only labor and sell to downstream firms and final consumers, whilst downstream firms produce using inputs purchased from upstream firms and sell only to final consumers. Compared to recent trade network models (see for example Tintelnot et al., 2018) we simplify the network by imposing a bipartite structure and allowing all downstream firms to purchase from all upstream firms at no (search) cost, we introduce a tax system and allow firms to choose to pay VAT or to in the simplified regime. We assume monopolistic competition, as is standard in the literature, and do not allow firms to under-report their tax liabilities to the tax authorities. We discuss these two assumptions at the end of the section.

3.1 Preferences and demand

The final consumer F is endowed with income E and has CES preferences over goods i:

$$U = \left(\sum_i (\beta_i q_{iF})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}. \tag{1}$$

where q_{iF} is the quantity of good i consumed by the final consumer. Writing p_{iF} the consumer price of good i, utility maximization yields the following demand for good i:

$$q_{iF} = \left(\frac{\beta_i}{p_{iF}} \right)^{\sigma} P_F^{\sigma-1} E \tag{2}$$

where $P_F = \left(\sum_i \beta_i^{\sigma} p_{iF}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ is the consumer price index. We assume that final goods are substitutes and therefore the (absolute value of the) elasticity of demand σ is greater than 1.

3.2 Production and market structure

Downstream firms produce goods k using a CES input bundle of goods j with elasticity of substitution $\rho > 1$. The production function of the firm producing good k, which we call firm k, is:

$$q_k = \phi_k \left(\sum_j \alpha_{jk} q_{jk}^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \tag{3}$$

where q_{jk} are the quantities of good j purchased by firm k, ϕ_k is a productivity parameter and the α_{jk} terms are technology parameters. Writing p_{jk} the price paid by k for good j, we can write demand of firm k for good j as:

$$q_{jk} = \frac{q_{kF}}{\phi_k} \left(\frac{\alpha_{jk} P_k}{p_{jk}} \right)^{\rho} \tag{4}$$

and firm k's cost function as:

$$c_k = \frac{P_k}{\phi_k} \text{ with } P_k = \left(\sum_j \alpha_{jk}^{\rho} p_{jk}^{1-\rho} \right)^{\frac{1}{1-\rho}} \tag{5}$$

where P_k is firm k's input price index.

Upstream firms produce goods j using only labor and sell to downstream firms k and final consumers. The production function of firm j is:

$$q_j = \phi_j \alpha_{\ell j} q_{\ell j} \tag{6}$$

Its cost function is $c_j = \frac{P_j}{\phi_j}$ with $P_j = \alpha_{\ell j} w$ where w is the exogenous cost of labor.

Finally, we assume the market structure is monopolistic competition so that firms sell to consumers at a mark-up $\mu = \frac{\sigma}{\sigma - 1}$ and to other firms at a mark-up $\nu = \frac{\rho}{\rho - 1}$.

3.3 Taxes and tax scheme choice

Downstream and upstream firms choose whether to pay taxes under the VAT scheme or under the simplified tax scheme. Under the VAT scheme firm i pays a tax t_i on its sales and deducts the VAT paid on its input purchases from its tax liabilities. Under the simplified scheme it pays a tax τ on its total sales and is constrained to sell less than a fixed amount $\bar{x}$. In what follows we assume that τ approximates to zero and all the VAT rate t_i are small compared to one. These assumptions are in line with our empirical context and simplify the expressions. The trade-offs associated with choosing a tax scheme in our setting are similar to the trade-offs associated with formality choice in De Paula and Scheinkman (2010).

We write v_i the tax status of firm i, $v_i = 1$ if i chooses to pay taxes under the VAT scheme, zero otherwise. Defining the tax wedges $\gamma_{iF} = 1 - \tau - v_i(t_i - \tau)$ and $\gamma_{jk} = (1 - \tau - v_j(t_j -$

$\tau) + v_j v_k t_j)$ we can write the prices to final consumers and to intermediate firms as:

$$p_{iF} = \frac{P_i \mu}{\phi_i \gamma_{iF}}, \forall i = j, k \tag{7}$$

$$p_{jk} = \frac{P_j \nu}{\phi_j \gamma_{jk}} \tag{8}$$

Firm i's profits when its sales are unconstrained can now be written as:

$$\Pi_i(v_i) = q_{iF}(\gamma_{iF} p_{iF} - c_i) + \sum_k q_{ik}(\gamma_{ik} p_{ik} - c_i), \forall i = j, k \tag{9}$$

We assume that firms choose the tax status v_i that maximizes their profit Π_i taking all other firms' tax status as given. Some firms choose the VAT scheme regardless of their size, governed by ϕ_i, other firms choose the simplified scheme for small values of ϕ_i, the VAT scheme for large values of ϕ_i and choose to sell exactly $\bar{x}$ and remain in the simplified scheme for intermediate values of ϕ_i. See the Appendix for a detailed characterization of firms' tax scheme choice.

3.4 Equilibrium

Market clearing implies that $q_k = q_{kF}, \forall k$ and $\sum_k q_{jk} + q_{jF} = q_j, \forall j$. An equilibrium is characterized by the tax status of all firms, $\{v_i\}$, which in turn determines prices and production through equations (2), (4), (7), and (8). From firm-level prices and production we then obtain each firm's position in the supply chain, which we characterize using the terms s_{jk}, the share of firm k's purchases from firm j in its total input costs, and λ_{jk}, the share of firm j's sales to firm k in its total sales. Below we also refer to equilibrium values in an world in which there are no taxes ($t_i = \tau = 0, \forall i$). In this world the supply chain parameters, $\tilde{s}_{jk}$ and $\tilde{\lambda}_{jk}$, are a function of technology, productivity and mark-up parameters only.

Our first proposition considers the impact of a change in a downstream firm k's tax scheme on its trade with upstream firms j, keeping the tax scheme of all other firms' constant.

Proposition 1. ***Impact of tax system on trade (supply chain distortions).*** *The effect of a change in downstream firm k's tax scheme on its trade with upstream firm j can be expressed as:*

$$\log(s_{jk}(v_k = 1)) - \log(s_{jk}(v_k = 0)) = (\rho - 1)(t_j v_j - \bar{t}_k s_{Vk0}) \tag{10}$$

where s_{Vk0} is the share of k's inputs purchased from VAT-paying suppliers when k is in the simplified

scheme and $\bar{t}_k$ is a weighted average of the VAT rates of the suppliers of firm k, defined by $(1-\bar{t}_k)^{\rho-1} = s_{Vk0}^{-1}\sum_j \tilde{s}_{jk} v_j (1-t_j)^{\rho-1}$.
Proof: see Appendix.

This proposition states that the tax system causes supply chain distortions: downstream firms will, all else equal, buy more from VAT-paying upstream firms when they themselves pay VAT. Consider the impact of a change in downstream firm k's tax scheme on how much it buys from an upstream firm j in the VAT scheme. Assuming for simplicity that $t_j = \bar{t}_k = t$, we obtain:

$$\log(s_{jk}(v_k = 1)) - \log(s_{jk}(v_k = 0)) = (\rho - 1)(1 - s_{Vk0})t \tag{11}$$

Expression (10) shows there will be partial market segmentation between VAT- and non-VAT-paying firms due to supply chain distortions, even in a world in which firms' tax schemes are exogenously given. Intuitively this is because firms pay a tax on their purchases from VAT-paying suppliers only if they themselves pay VAT: inputs purchased from suppliers in the VAT scheme are cheaper for firms in the VAT scheme than for firms in the simplified scheme. The effect of downstream firm k's tax scheme on its purchases from a VAT-paying supplier j is moreover decreasing in s_{Vk0}, how much the firm buys from VAT-paying suppliers when it is in the simplified scheme. This effect goes through firm k's input price index P_k: the more k buys from VAT-paying suppliers the more P_k decreases when it becomes VAT, mitigating the effect of the decrease in input cost of any particular VAT-paying supplier. At the limit when firm k already buys all its inputs from VAT-paying suppliers when in the simplified scheme (s_{Vk0}) the relative price of its inputs is unaffected by its choice of tax scheme.[8] A change in its tax scheme therefore does not affect its input mix.

Our second proposition characterizes the impact of firms' supplier networks on their propensity to choose to pay taxes under the VAT scheme. We define a firm's propensity to choose the VAT scheme as the difference between the profit it obtains when in the VAT scheme and the profit it obtains in the simplified tax scheme. Firms' position in supplier networks are by definition endogenous to their choice of tax scheme so we write firms' tax scheme choice as a function of their position in the no-tax network which is exogenous to their tax choices.

Proposition 2. ***Strategic complementarities in firms' tax scheme choice.*** *Firm i's propensity to choose the VAT scheme is:*

[8] This will be the case if $\alpha_{jk} = 0$ for suppliers j for which $v_j = 0$.

1. *Decreasing in the firm's own VAT rate t_i.*

2. *Increasing in $t_i\tilde{\lambda}_{iV}$ where $\tilde{\lambda}_{iV} = \sum_k v_k\tilde{\lambda}_{ik}$ is the share of i's sales sold to VAT-paying clients, where each client is weighted by its sales share in the no-tax world.*

3. *Increasing in $\tilde{s}_{Vi}\bar{t}_i$, where $\tilde{s}_{Vi} = \sum_j v_j\tilde{s}_{ji}$ is the share of i's inputs purchased from VAT-paying suppliers, where each supplier is weighted by its input share in the no-tax world, and $\bar{t}_i$ is a weighted average of the VAT rates of i's suppliers: $(1-\bar{t}_i)^{\rho-1} = \tilde{s}_{Vi}^{-1}\sum_j \tilde{s}_{ji}v_j(1-t_j)^{\rho-1}$.*

In addition, firm's propensity to bunch - produce exactly $\bar{x}$ to remain in the simplified tax scheme - is also decreasing in t_i and increasing in $t_i\tilde{\lambda}_{iV}$ and $\tilde{s}_{Vi}\bar{t}_i$. Proof: see Appendix.

This proposition states that there are strategic complementarities in firms' tax decisions within supply chains: the more a firm buys from, and sells to, VAT-paying firms, the more likely it is to itself choose to pay VAT. Intuitively, firms with many potential VAT-paying suppliers will face a lower input price index if they choose to be in the VAT scheme rather than in the simplified scheme. Similarly firms with many potential VAT-paying clients will face more demand for their products if they choose to be in the VAT scheme.

3.5 Discussion

Two of our assumptions warrant discussion. First, our assumption of monopolistic competition implies that firms fully pass-through taxes to their clients: the full incidence of taxes is paid by the buyer at all stages of production (equivalently, suppliers' mark-ups are not affected by taxes). This assumption, whilst restrictive, is not key to deriving our propositions. Intuitively both supply chain distortions and strategic complementarities stem from the fact that the tax system introduces a wedge between the price paid by the buyer and that received by the seller for only some transactions – those between firms in different tax schemes, and between firms and final consumers. This wedge decreases the relative returns to trade between firms in different tax scheme regardless of which of the trading partners effectively bears the burden of the tax. In a different model in which suppliers bear part of the cost of taxation, VAT-paying suppliers would earn lower mark-ups the more they sell to non-VAT-paying clients. This would also lead to less trade, all else equal, between VAT-paying suppliers and clients in the simplified scheme. Proposition 2, which states that firms' propensity to choose the VAT scheme is a function of the tax scheme of their suppliers and clients, would similarly be unaffected. This assumption does however affect the functional form taken by the mechanisms of interest and therefore the interpretation of our empirical estimates. We discuss this point when presenting our empirical results below.

Second, we assume firms pay taxes on their total tax liabilities: they cannot hide part of their real activity from the tax authorities. In doing so we abstract from the possibility that the reporting of transactions between VAT-paying firms by both parties involved in the transaction could affect firms' compliance decisions, and in particular their decision to under-report part of their sales. This assumption is motivated both by a limitation of our data (we only observe reported sales and have no information on evasion) and the empirical evidence, discussed above, showing that firms report substantially more sales to the tax authorities than the total of their third-party-reported sales. The compliance characteristics of the VAT are moreover well studied in the existing literature (see in particular Pomeranz, 2015). We return to the possibility that some transactions may be under-reported when discussing potential sources of bias in our empirical estimates below.

Overall the model predicts that there will be partial segmentation of supply chains between VAT- and non-VAT- paying firms in equilibrium, because of two mechanisms. The supply chain distortions mechanism, detailed in Proposition 1, holds even when firms' tax schemes are exogenously given: because inputs produced by VAT-paying firms are cheaper for VAT-paying clients than for non-VAT-paying clients the tax system distorts firms' choice of input mix and leads to more transactions, all else equal, between firms in the same tax scheme than between firms in different schemes. The strategic complementarities mechanism, detailed in Proposition 2, states that a firm's tax status decision is a function of that of its trading partners: firms with many VAT-paying trading partners are more likely to choose to oat VAT, re-enforcing market segmentation. The following sections provide evidence regarding both mechanisms.

4 Empirical strategy

4.1 Graphical evidence

Our model predicts that VAT-paying firms trade more with other VAT-paying firms than firms in the simplified scheme. In particular we predict that firms that trade more with VAT-paying firms will be less likely to bunch, ie constrain their sales to be just under the 5 million threshold in order to qualify for the simplified tax scheme, than firms that trade little with VAT-paying firms. Figure 2 shows this prediction is borne out by the data. We plot the distribution of firms by turnover around the threshold separately for firms with below and above median shares of sales sold to VAT-paying clients and shares of intermediate inputs purchased from VAT-paying suppliers. We see clear evidence of bunching below the threshold, but more so among firms that sell less to, and purchase less

from, VAT-paying firms. The model also predicts that firms facing a higher VAT rate will be more likely to bunch when their share of sales to VAT-paying clients decreases, relative to firms facing a low VAT rate. Figure 3 tests this prediction by plotting density distributions for firms with high and low shares of sales to VAT clients separately for firms in the low and medium tax schedules and firms in the high tax schedule. We see substantially more bunching among firms with a low share of VAT sales in the group facing a high VAT rate than in the group facing a low VAT rate.

This graphical evidence is in line with the model's predictions, but unobserved firm characteristics may be driving part of the cross-sectional correlation between firms' tax scheme choice and trade with VAT-paying firms. In what follows we address this concern by using within-firm and within-trading relationships changes over time to estimate both the causal effect of the tax system on firms' sourcing decisions and strategic complementarities in firms' tax choices. Figure 4 presents graphical evidence regarding the within-firm correlation over time between tax status and trade. It plots the average share of intermediate inputs purchased from VAT-paying firms before and after firms change tax scheme (blue line for firms switching from the simplified to the VAT scheme, red line for firms switching from the VAT to the simplified scheme) as well as the average in each year for firms that never change tax status. We observe 7,648 firms changing tax scheme over time, 60% of them go from the simplified scheme to the VAT scheme. We see a clear positive correlation between a firm's decision to switch to a new tax status and its sourcing decisions, with firms buying 9 percentage points more of their inputs from VAT-paying firms when they enter the VAT scheme. This correlation suggests at least one of the mechanisms outlined by our model is at play: firms may be entering the VAT scheme because their suppliers enter the VAT scheme (strategic complementarities) and/or buying more from VAT suppliers because they've chosen to enter the VAT scheme (supply chain distortions). This section presents the empirical strategy that enables us to separately estimate the magnitude of each mechanism.

4.2 Supply chain distortions

We test Proposition 1 by considering the causal effect of a change in firms' tax status on their sourcing decisions. Specifically we estimate the impact of a change in client k's tax scheme on its purchases from VAT-paying supplier j using the following empirical equivalent of expression (11):

$$\log(s_{jkt}) = \beta_1 v_{kt} + \beta_2 v_{kt}(1 - s_{Vk}) + \gamma_t + \gamma_{jk} + \gamma_{jt} + \epsilon_{jkt} \tag{12}$$

where s_{jkt} is the share of the transaction between client k and supplier j in k's total intermediate input purchases in year t, $v_{kt} = 1$ if the client k is in the VAT scheme, 0 otherwise, s_{Vk} is the average share of k's inputs purchased from VAT-paying suppliers when k is in the simplified scheme, γ_{jk} is a pair jk fixed effect and γ_{jt} different year fixed effects for each supplier.[9] We allow for potential changes in input mix as firms grow by controlling for the client firm k's turnover. Because the client's turnover can be determined jointly with its VAT choice when firms are close to the 5 million threshold our preferred specification considers only pairs in which the client has a turnover of less than 4 million INR.[10] We allow for correlation in error terms both within location (postcode) and within types of product sold by firm k.

Our model predicts $\beta_1 > 1$ and $\beta_2 < 0$. In addition expression (11) states that both the magnitudes of β_1 and β_2 are increasing in the VAT rate paid by the supplier, so we split our sample between pairs in which the supplier pays the high and the low VAT rate to test this prediction. We can test our prediction that a change in tax status will have no impact on trade if the client purchases all its inputs from VAT suppliers by testing that $\beta_2 + \beta_1 = 0$. Finally, under our assumptions of monopolistic competition and CES production our estimate of β_1 can be used to identify the elasticity of substitution in production ρ using the expression $\beta_1 = (\rho - 1)\frac{t_j}{1-t_j}$.

Expression (11) states that both β_1 and β_2 are a function of the VAT rate paid by the supplier j so we estimate (12) first on the sample of pairs in which the supplier pays the medium VAT rate, then on the sample of pairs in which the supplier pays the high VAT rate. Our model predicts $\beta_1 > 1$, $\beta_2 < 0$. Under our assumptions of monopolistic competition and CES production our estimate of β_1 can be used to identify the elasticity of substitution in production ρ using the expression $\beta_1 = (\rho - 1)\frac{t_j}{1-t_j}$. We can test our prediction that a change in tax status will have no impact on trade if the client purchases all its inputs from VAT suppliers by testing that $\beta_2 + \beta_1 = 0$. Our model also predicts that β_1 is increasing in the VAT rate paid by the supplier, we split our sample between pairs in which the supplier pays the high and the low VAT rate to test this prediction.

Several identification challenges must be addressed for specification (12) to identify the causal effect of within firm changes in tax scheme over time on their trade with VAT firms. First, strategic complementarities (or shocks correlated across potential trading partners)

[9] For firms that are never observed in the simplified scheme we use the average share of inputs from VAT suppliers over the period. Note that these firms are not used to identify β_2.

[10] To be consistent with our other threshold choices we include all clients whose minimum turnover over the period is less than 4 million INR. Results are unaffected if we restrict the sample instead to pairs in which the client has a maximum turnover over the period of less than 4 million.

and the fact that we do not observe trade between firms in the simplified tax scheme may lead to reverse causality: if two firms j and k trade whilst in the simplified scheme, and firm j enters the VAT scheme in the same year t as firm k we will observe no trade between j and k before t and positive trade after t, even if the real trade between both firms does not change in year t. To circumvent this issue we restrict our sample to pairs (j, k) in which the supplier j is always much bigger than the eligibility cut-off size (our cutoff in our baseline specification is supplier's minimum turnover over the period larger than 7 million INR). This ensures that the supplier is constrained to remit VAT throughout the period, and that if the pair trades we always observe the transaction.

Second, some pairs may be more likely to trade for reasons we do not model but are correlated with their tax status. Firms whose owners belong to the same community for example may be more likely to both trade with each other and share information on the tax system. We allow for such unobserved time-invariant determinants of trade by including pair fixed effects (γ_{jk}) in all specifications. Third, reverse causality may be a cause for concern even when we restrict the sample to pairs in which the potential suppliers is always in the VAT scheme. Shocks to VAT firms' productivity may make them more attractive to all potential clients and induce some non-VAT firms to buy from them. Strategic complementarities imply that some of these firms may choose to enter the VAT scheme because they have acquired a new VAT supplier. We include supplier$\times$year fixed effects (γ_{jt}) to allow for such unobserved changes in suppliers' productivity over time. Our preferred specification thus identifies the causal effect of interest by comparing the relative changes over time in trade between a large VAT-paying supplier and its clients that change tax status and those that do not. Our identifying assumption is that there are no unobserved pair-specific productivity shocks that vary over time and lead some clients to start trading with large VAT suppliers and change tax scheme.

Finally, we restrict our attention to pairs (j, k) that trade at least once over the period in years during which both firms k and j file tax returns. We impute a value equal to the minimum reporting threshold of 50,000 INR to transactions between firms that do not trade in a given year. Our baseline sample consists of 2.6 million observations and 506,787 pairs, in 32,144 pairs the client changes tax status over the period.

Table 3 presents descriptive statistics on the sample used to estimate (12), separately for pairs in which the supplier faces the medium VAT rate and those in which it faces the high VAT rate.[11] We see that the firms are only observed trading 55-61% of the time, so there is

[11]There are very few pairs in which the supplier faces the super-reduced 0% and 1% rates (2% of our sample). Our model predicts $\beta_1 = 0$ for these pairs, but there are to few such pairs in which the supplier

substantial variation on the extensive margin of trade. The average transaction represents a very small share of suppliers' sales (0.5%) but a non trivial share of client's intermediate inputs, as expected in a sample of pairs in which the client is small and the supplier large. Our identification strategy relies on comparing clients of the same supplier over time, it is therefore reassuring to see that the average supplier has 83 clients in the medium tax group and 133 clients in the high tax group (the median number of clients are, respectively, 43 and 44).

4.3 Strategic complementarities in tax choices

We test Proposition 2 in our model by estimating the causal effect of changes in how much firms trade with VAT-paying firms on their choice of tax scheme. Following our predictions for firms' tax scheme choice we estimate the following equation:

$$v_{it} = \delta_1 t_i \sum_k \lambda_{ikt} v_{kt} + \delta_2 \sum_j t_j s_{jit} v_{jt} + \gamma_i + \gamma_{gt} + \epsilon_{it} \tag{13}$$

where v_{it} is equal to 1 if firm i is in the VAT scheme in year t, λ_{ik} is the share of i's sales sold to firm k, s_{ji} is the share of i's intermediate inputs purchased from firm j, and γ_i and γ_{gt} are respectively firm and year×product fixed effects.[12] We allow for correlation in error terms both within location (postcode) and within types of product sold by firm i.

We estimate specification (13) on the sample of firms that can choose between the simplified and the VAT scheme. As detailled above we observe some bunching of firms just below the 5 million INR threshold above which firms can no longer opt for the simplified scheme. All the extra mass just below the threshold is composed of firms in the simplified scheme, which would produce more than 5 million had they chosen the VAT scheme. We therefore also include firms 'just above' the threshold in our sample, as these firms could make themselves eligible to the simplified scheme by reducing their production. Our baseline specifications include all firms with a minimum turnover over the period of less then 7 million INR.

Our estimates of interest – δ_1 and δ_2 – are 'supplier network effects' similar to the social effects estimated in the social networks literature (see for example Giorgi et al., 2010). Several challenges arise when attempting to identify such network effects; to circumvent them we use instruments for the terms $t_i \sum_k \lambda_{ik} v_{kt}$ and $\sum_j t_j s_{ji} v_{jt}$ in which we shut down

has several clients and at least one of them changes tax scheme over time for us to test this prediction. We therefore exclude these pairs from the analysis.

[12] We include product×year fixed effects to control for potential effects of the small increase in VAT rates on most product during the period.

several sources of variation that bias our estimates. First, our model makes clear that the structure of the network (the existence and size of a link between two firms) is endogenous to firms' tax status decision: Proposition 1 tells us that firms will trade more with VAT-paying firms when they choose to pay VAT. Using the observed network would therefore bias our estimates upwards. The model also offers a solution to this problem: the relevant network is not the realized network but the potential network in the absence of taxes, characterized by the $\tilde{\lambda}_{ik}$ and $\tilde{s}_{ji}$ terms. We use the pair-level average shares over time to proxy for the potential network. The observed shares between two firms in the VAT scheme are approximately equal to the potential shares, as transactions between VAT-paying firms are not distorted by the tax system, using this proxy introduces measurement error for other pairs.[13] However this method means that our network variables are time-invariant; combined with firm fixed effects this specification ensures that changes in the network, or different firm positions within the network, cannot be driving our estimates.

Second, network effects naturally give rise to a reflection problem, compounded by the possibility of unobserved correlated effects across firms driving tax choices (Manski, 1993). This implies that using variations in the right-hand-side variables that comes from changes in firms' trading partners' tax schemes over time could also bias the estimates. In practice however only a small share of the within-firm variation in both these variables comes from changes in firms' trading partners tax status (less than 5%). This is because firms that change tax status over time are by definition small, and represent only a small fraction of their trading partners' sales and input purchases.[14] We shut down this source of variation by holding the tax status of firm i's trading partners fixed. To do this we set v_{kt} and v_{lt} equal to the tax scheme of firms k and l observed in their first year in the data, v_{k0} and v_{l0}. The variation that remains comes from the fact that firms' trading partners enter and exit the data over time. We observe on average 9% of firms entering the data, and 8% exiting the data, in each year.[15] When firms are not in our data they are either not operating, or operating in the informal sector and therefore not filing taxes. Under both these scenarios entry and exit of a firm's VAT-paying trading partner changes how much this firm can potentially trade with VAT-paying firms.

We therefore estimate equation (13) using as instruments for the right-hand-side variables

[13] Observed shares are exactly equal to first best shares for transactions between VAT-paying firms if $\tau = 0$. In practice τ is very low (0.25%) so this approximation is reasonable.

[14] Small VAT-paying firms only buy 17% of their intermediate inputs from other small VAT-paying firms (one-fourth of their total inputs from VAT-paying firms), and sell them 11% of their sales (one-third of their total sales to VAT-paying firms).

[15] Entry and exit rates are lower for firms with a turnover of more than 7 million (5% entry rate, 4% exit rate), but comparable across tax scheme among firms with a turnover of less than 7 million: entry (exit) rates are 8% (8%) for firms in the simplified tax scheme, 11% (10%) for firms in the VAT scheme.

the predicted share of the firm's sales it can potentially sell to VAT-paying clients, and the predicted share of its intermediate input purchases it can potentially buy from VAT-paying suppliers. We use average trade shares to proxy for predicted trade and set the tax scheme of the firm's trading partners equal to their first tax scheme; the only source of variation over time in our instruments comes from the fact that potential VAT-paying trading partners enter and exit from the data over time. Formally, we use as instruments the variables $t_i \sum_k \tilde{\lambda}_{ik} v_{k0} e_{kt}$ and $\sum_j t_j \tilde{s}_{ji} v_{j0} e_{jt}$ where e_{kt} (e_{jt}) is a variable equal to 1 if supplier k (client j) is in the data in year t, 0 otherwise. These instruments enable us to identify our estimates of interest under the assumption that entry and exit of firms' VAT-paying trading partners only affect their tax status decision through their propensity to sell to, or buy from, VAT-paying firms. Because entry and exit of trading partners likely affect firms' size this identification assumption is potentially violated for firms close to the 5 million INR threshold for which size is co-determined with the tax scheme choice. We therefore also present results obtained on a sample of firms whose turnover is less than 4 million INR, controlling for firms' size, to check that the effects of entry and exit on firm size are not driving our results.

Appendix Table B.3 presents descriptive statistics on the sample used to estimate equation (13). We see that over 90% of firms have at least one VAT-paying trading partner over the period, and 60% have at least one VAT-paying trading partner that exists or enters over the period. These trading partners are much larger than the firms whose choice of tax status specification (13) seeks to explain, their entry or exit from the data therefore represent substantial changes to how much these firms can trade with VAT-paying firms.

5 Results

5.1 Supply chain distortions

Table 4 presents results obtained by running specification (12), where the outcome variable is the log of the ratio of the transaction between two firms to the total intermediate input purchases of the client. In the first three columns the sample consists of all pairs in which the supplier is in the medium tax schedule (facing a VAT rate of 4-5%), and in the last three columns the supplier is in the high tax schedule (facing a VAT rate of 12.5-13.5%). Columns 2-3 and 5-6 present results obtained using our preferred specification with supplier×year fixed effects to allow for unobserved shocks to suppliers' productivity.

Results indicate that the average firm trades more with VAT suppliers when it enters the VAT scheme. Effects are smaller, as expected, when we include supplier×year fixed effects.

On average firms that enter the VAT scheme buy 11% more from their VAT-paying suppliers in the medium tax scheme (column 2), 17% more from those in the high tax scheme (column 5) – 12% on average across the whole sample. The relative magnitude of the effects in the two sub-sample is also roughly in line with the model's prediction that the causal effect of a client entering the VAT on trade with VAT-paying suppliers is increasing in the tax rate paid by the suppliers.

Columns 3 and 6 show that effects vary with how much the firm trades with VAT-paying suppliers when in the simplified scheme: the effect of joining the VAT scheme is smaller the higher the client's share of intermediate inputs purchased from VAT-paying suppliers when in the simplified scheme. The estimates imply that there is no effect of joining the VAT scheme on trade with VAT-paying suppliers for a firm that only buys its inputs from VAT suppliers regardless of its tax scheme (VAT input share equal to 1), in line with the model's predictions. Appendix Figure B.4 plots the estimates of the effect of the client entering the VAT obtained for each quintile of the distribution of the VAT input share variable. We see that the effect is decreasing with how much the client buys from VAT suppliers when in the simplified scheme in both sub-samples.

We present several robustness checks in the Appendix. First, we consider the possibility that VAT-paying suppliers under-report transactions with clients in the simplified tax scheme; this would bias our results upwards. To do so, we remove from the sample all pairs in which the supplier has a share of third-party-reported sales to total sales of more than 90%, because these suppliers may have an incentive not to report clients in the simplified scheme to lower their tax liabilities. This reduces our sample size by 25% but estimates are very similar, suggesting under-reporting of transactions is not driving our results (see Appendix Table B.4, panel A).[16] Results are also unaffected when we allow for location specific shocks (Appendix Table B.4, panel B) or consider alternative sub-samples of potential pairs (Appendix Table B.5): including all pairs in which clients could be eligible to the VAT scheme (those in which the turnover of the client is less than 7 million) or restricting the sample to pairs in which the supplier is very far from the eligibility threshold (turnover higher than 10 million). Overall, firms trade 10-12% more with VAT-paying suppliers in the medium tax scheme and 15-20% more with those in the high tax scheme when they enter the VAT scheme. We obtain similar results when using an indicator equal to one if the pair trades as an outcome variable, suggesting most of the effects are driven by firms deciding whether or not to trade (see Appendix Table B.4, panel C).

[16]Only 10% of the firms in our data sell more than 90% of their sales to other tax-registered firms but these firms are over-represented in this sample because they are more likely to sell goods to other firms.

Our estimates can be compared to the existing literature in two ways. The value of the elasticity of substitution in production ρ that our results imply (under our assumptions of CES production and monopolistic competition) is relatively stable across samples and takes a value between 4 and 7. This is within the range of estimates reported in the literature, though previous work typically does not use firm-level transaction data to identify this parameter (see for example Broda et al., 2017). In our model $\rho - 1$ is also the trade elasticity (elasticity of trade shares with respect to trade costs). Our estimates imply that this elasticity is in the -3 to -6 range in this sample, again well within the set of estimates obtained in the existing literature (see Bartelme et al., 2018, for a review of the range of estimates in the trade literature).

5.2 Strategic complementarities in tax choices

Table 5 presents results obtained by running specification (13) which models a firm's tax scheme choice as a function of the share of its intermediate inputs purchased from VAT-paying suppliers (where each supplier is weighted by its VAT rate) and the share of its sales sold to VAT-paying clients (multiplied by the firm's own VAT rate). The dependent variable is an indicator equal to 1 if the firm pays taxes under the VAT scheme, 0 otherwise. All columns include firm and year fixed effects. The first three columns are obtained on the sample of all firms with a minimum turnover of less than 7 million INR, and the last three columns on the sample of all firms with a minimum turnover of less than 4 million INR. In the last three columns our specifications always include a control for the firm's turnover.

We first present OLS results in columns 1 and 4. We find that changes over time in how much firms trade with VAT-paying firms are positively correlated with changes in firms' decisions to pay VAT. Variation in these trade shares over time come from three sources: i) changes in trade between firms ii) changes in the tax status of the firms' clients and suppliers iii) entry and exit of clients and suppliers. The first two sources likely bias the estimates upwards relative to the causal effect of interest; in columns 2 and 5 we present reduced form results in which the right-hand-side variables are our predicted trade instruments, which only vary over time because of entry and exit of the firms' VAT-paying trading partners. This reduces the magnitude of the estimates, as expected, but the estimated effect of changes in predicted trade with VAT firms on firms' choice of tax scheme are large and statistically significant. These instruments are strong predictors of how much firms trade with VAT-paying firms. Appendix Table B.6 presents first stage results, we find that a 10% increase in predicted trade with VAT-paying firms leads to a 6-8% increase in observed trade with VAT-paying firms. We compute the conditional F-statistics testing for weak in-

struments with multiple endogenous variables (Sanderson and Windmeijer, 2016). For all specifications, the values of these F statistics are much higher than the 5% Stock-Yogo critical values for a maximal 10% size of Wald tests for the two endogenous regressor, two instruments case, equal to 7.03.

In column 3 we present results using our preferred specification in which the predicted trade shares are used as instruments for the observed trade shares with VAT-paying firms. Estimates are similar when we restrict the sample to firms far away from the threshold above which they have to be in the VAT scheme and control for firm size in column 6, suggesting the effect isn't driven by firms changing both size and tax status when they acquire or lose a trading partner. Appendix Table 5 shows that the magnitudes of the effects are also unaffected when we change the thresholds used to define our sample or include year×location fixed effect to allow for local shocks which could potentially affect both entry dynamics and firms' choice of tax scheme.

Overall, we find that increases in how much firms can trade with VAT-paying suppliers and clients increase these firms' propensity to pay VAT: a 10% increase in the (weighted) share of a firm's intermediate inputs purchased from VAT-paying suppliers increases the probability that this firms pays the VAT by 5-6 percentage points, and a 10% increase in the weighted share of firm's sales that are sold to VAT-paying clients increases this probability by 1.2-1.7 percentage points. These estimates imply that a firm facing a VAT rate of 13.5% and whose suppliers also face that rate will increase its propensity to pay the VAT by 8 to 10 percentage points if all its trading partners simultaneously change tax scheme and start paying VAT.[17]

5.3 Explaining supply chain segmentation

How much of the segmentation in supply chains observed in Table 2 can be explained by our two mechanisms? We use our estimates of supply chain distortions and strategic complementarities to compute counterfactual firm-to-firm trade and tax-scheme choices in a world in which neither of these mechanisms are at play, i.e. a world in which the tax system does not distort trade. We then estimate the counterfactual correlations between firms' decision to pay taxes under the VAT scheme and how much they trade with VAT-paying firms, and compare this to the observed correlations. Results are presented in Table 6 in which the first column shows the observed correlation (conditional on firms' products

[17]These numbers are obtained by multiplying our estimates of strategic complementarities by the VAT rate, here 0.135. Using the estimates from column 6 in Table 5 we find $0.135 \times (0.501 + 0.136) = 0.086$.

and locations) between the share of firms' sales sold to VAT-paying clients, the share of firms' inputs purchased from VAT-paying suppliers, and firms' own tax scheme choice.

We start by considering what happens if firms' sourcing decisions are no longer distorted by the tax system, but firms' choice of tax scheme is held constant. Formally, we construct counterfactual firm-to-firm trade in the absence of supply chain distortions by increasing the trade between clients in the simplified tax scheme and suppliers in the VAT scheme by a factor $1 + (\hat{\rho} - 1)\frac{t_j}{1-t_j}(1 - s_{Vk0})$ where our estimates of ρ are those obtained in Table 4. We assume firms' total inputs purchased and total sales are unaffected, so removing supply chain distortions only leads to a re-allocation of trade. In this counterfactual supplier network VAT-paying suppliers therefore sell more to their clients in the simplified scheme, and less to their clients in the VAT scheme. Results are presented in column 2 of Table 6. We see that the correlation between a firm's tax status choice and the share of its sales sold to VAT-paying clients is roughly the same under our counterfactual trade scenario as the real correlation, but the counterfactual correlation with the share of inputs purchased from VAT-paying suppliers is 25% smaller.

We then simulate firms' tax scheme choice in a world in which there are no strategic complementarities in firms' tax choices, holding firm-to-firm trade constant. We start by considering how much of small firms' decision to pay the VAT can be explained by their trade with firms that are constrained to pay the VAT because of their size (firms with a minimum turnover of more than 7 million). To do so, we use our estimates of strategic complementarities presented in Table 5 and obtain for each firm the probability that it pays VAT in a counterfactual world in which it is not influenced by the tax status of its large trading partners. We then compute for each firm how much it sells to, and buys from, VAT-paying partners in this counterfactual world, using partners' predicted probability of being in the VAT scheme. Results are presented in column 3 of Table 6. Removing strategic complementarities between large and small firms decreases the correlation between the probability that small firms pay the VAT and how much they buy from VAT-paying suppliers by 16%, but hardly affects the correlation with how much they sell to VAT-paying clients.

The fact that some small firms have a lower propensity to pay the VAT in this counterfactual world can further lower this propensity for other small firms, to the extent that small firms trade with each other. Results in column 4 present results in which we also take into account the effect of firms' small trading partners choice of tax scheme on their probability of paying VAT: we use our estimates of strategic complementarities to obtain for each firm the probability that it pays VAT in a world in which it is not influenced by the tax status of *any* of its trading partners. Comparing columns 3 and 4 we see that also allowing for small

firms' tax decisions to interact enables us to explain a slightly larger share of the observed segmentation in supply chains, suggesting there is some potential for multiple equilibria in our setting. This potential is limited by the fact that, whilst small firms do trade with each other, this trade represents a small share of their total trade. Small VAT-paying firms only buy 17% of their intermediate inputs from other small VAT-paying firms (one-fourth of their total inputs from VAT-paying firms), and sell them 11% of their sales (one-third of their total sales to VAT-paying firms).

The last column in Table 6 presents correlations between firms' propensity to pay VAT and how much they trade with VAT-paying firms in a counterfactual world in which there are no supply chain distortions due to the tax system or strategic complementarities. We see that the two mechanisms together explain nearly half of the correlation between firms' propensity to pay VAT and how much they buy from VAT-paying suppliers, but less than 5% of the correlation with how much they sell to VAT-paying clients.

Overall, our model explains a substantial share of the segmentation in upstream firm-to-firm markets, but not in the more downstream markets. This can be explained by several factors. First, the counterfactual increase in trade between VAT-paying suppliers and non-VAT-paying clients in the absence of supply chain distortions represents a non-trivial share of the clients' inputs, but a much smaller share of the suppliers' sales. This is because VAT-paying suppliers are much larger than their average client (see Table 3). Second, we find smaller strategic complementarities effects with respect to a firm's suppliers than to its clients (see Table 5). Third, and relatedly, our estimates do not take into account the behavioral response of final consumers to the tax system. Consumers in our model behave like non-VAT-paying firms: they pay VAT on their purchases from VAT-paying firms and will therefore buy more, all else equal, from firms in the simplified scheme. Consumers' willingness to substitute across retailers in the two tax schemes could therefore explain part of the correlation in more downstream markets between how much firms sell to VAT-paying firms and their choice of tax scheme. In the absence of data on firm-to-consumer sales this mechanism is not one we can take into consideration.

Finally, note that all the correlations presented in Table 6 are conditional on location$\times$product fixed effects. This specification is appropriate if firms' locations and product affect their choice of tax scheme for reasons unrelated to the tax system. It may however lead us to under-estimate both the extent of segmentation in supply chains and how much our two mechanisms explain this segmentation if there are multiple equilibria leading to firms in local supply chains to all choose the same tax scheme. Appendix Table B.8 presents unconditional observed and counterfactual correlations. Our main result is unchanged: we can

explain a substantial share (slightly over half) of the segmentation in upstream markets, but cannot explain much of the segmentation in downstream markets.

5.4 Policy implications

Our results have several implications for tax policy. First, they allow us to revisit debates regarding the relative efficiency of Value-Added-Taxes with respect to Retail Sales Taxes (RST) – taxes paid only by retailers. In a world with perfect tax compliance these two taxes are equivalent (Kopczuk and Slemrod, 2006). In contexts with imperfect compliance, previous literature has pointed out that the VAT may be more revenue efficient because third-party-reporting on firm-to-firm transactions increases compliance (see for example Pomeranz, 2015). Our supply chain distortions mechanism implies however that there is also a production-efficiency disadvantage of the VAT with respect to the RST when some firms in the economy do not pay VAT: these firms' sourcing decisions are distorted by the VAT, but not by a RST.

Our evidence regarding the existence of strategic complementarities in firms' tax choices points to another difference between the two tax systems. Strategic complementarities imply that tax interventions that incentivize some firms to start paying VAT will have spillover effects on these firms' supply chains, as some of their suppliers and clients will also start paying VAT. These spillover - or multiplier - effects are intrinsically neither good or bad from a policy perspective. However, in contexts in which many firms do not pay taxes, strategic complementarities will increase the tax returns of such interventions.

Finally, our results speak directly to the potential impact of India's recent large-scale VAT reform, known as the GST (General Sales Tax). Prior to the introduction of GST in 2017 each Indian state had its own VAT system and transactions across state borders were taxed: VAT-paying firms were unable to deduct VAT paid on inputs from another state from their own VAT liability. The GST reform created a centralized VAT system which harmonizes taxes across all Indian states, and in particular allows for VAT paid on inputs to be deducted by VAT-paying firms even when the buyer and the seller are in different states. This paper's result suggest this reform has boosted inter-state trade by removing distortions in VAT-paying firms' sourcing decisions across suppliers in different states, thus increasing market integration in India. The strategic complementarities mechanism moreover implies that some firms may have joined the VAT as a consequence of the GST reform: the introduction of across-state VAT-deductability increased the relative returns from paying VAT for firms that trade with clients or suppliers in another state.

6 Conclusion

In this paper we set out to understand how tax policy affects firm-to-firm trade and how firms' tax decision are linked within supply chains, focusing on the role of VAT in a large developing economy. We use novel panel data from the state of West Bengal in India in which we observe both VAT- and non-VAT- paying firms and firm-to-firm transactions. This enables us to document the segmentation of supplier networks between firms in different tax schemes (VAT-paying and non-VAT-paying firms). We find evidence that VAT-paying firms trade more with other VAT-paying firms, all else equal, than non-VAT-paying firms.

To help us understand the mechanisms leading to market segmentation we then build a model of firms' sourcing and tax decisions within supply chains. Our key prediction is that under a VAT system there is partial market segmentation by tax status in equilibrium for two reasons. First, the VAT's incentive structure leads to supply-chain distortions: all else equal a VAT-paying firm buys a higher share of its inputs from VAT-paying suppliers than a non-VAT-paying one does. Second, there are strategic complementarities in firms' tax decisions: firms are more likely to choose to pay VAT the more VAT-paying suppliers and clients they have.

We finally provide empirical evidence on the mechanisms defined by our model using within-firm and within supplier-client pairs variations over time. We find that firms buy 12% more from VAT-paying suppliers on average when they themselves choose to pay VAT. Our estimates imply a trade elasticity and an elasticity of substitution in production that are within the range of estimates obtained in the international trade literature. We also find evidence of strategic complementarities in firms' tax choices. Our estimates imply that forcing all of a firm's trading partners to pay the VAT would increase that firm's propensity to pay the VAT by 8-10 percentage points compared to a situation where none of that firm's trading partners pay VAT.

Our findings have wide-ranging implications for tax policy in developing countries, most of which use a form of VAT. A key characteristic of these countries is that tax-paying firms co-exist in markets, and potentially trade with, a large number of non-tax paying firms in the informal sector. Our results regarding how the tax system affects trade between VAT and non-VAT-paying firms (here, firms paying taxes under a simplified tax scheme) naturally extend to trade between VAT-paying firms and informal firms, which we cannot observe in our data. Informal firms, like the firms in the simplified tax scheme we consider, pay taxes on purchases from VAT-paying suppliers and are therefore less likely to source inputs from them than from other informal firms. The magnitude of the effects we estimate suggest these distortions in input mix could be substantial. We similarly expect strategic

complementarities in firms' decisions of whether to enter the formal sector under a VAT system. Our results imply that a compliance shock causing some firms to start paying VAT will have spillover effects on these firms' supply chains: their informal trading partners may start paying VAT themselves.

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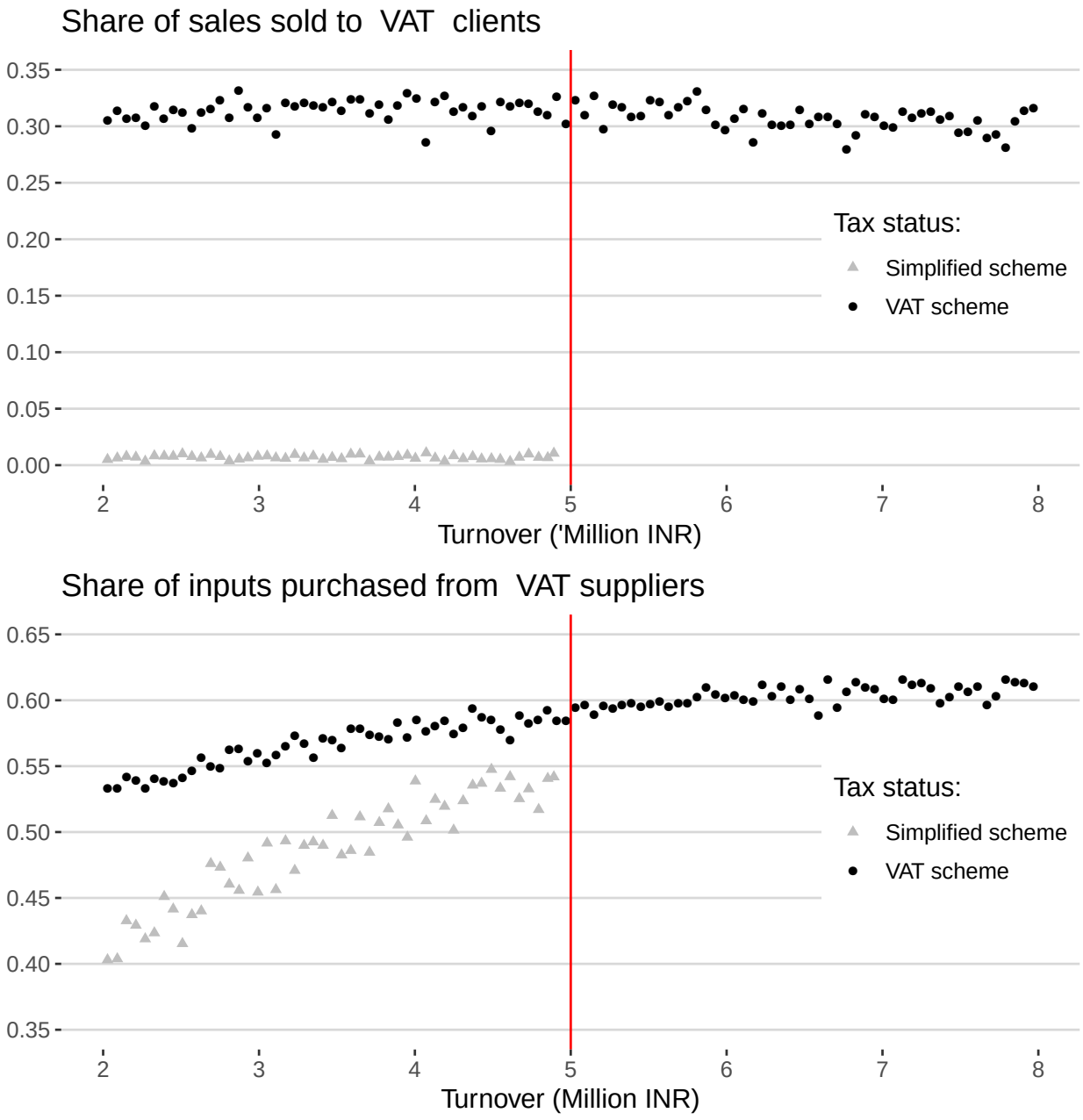
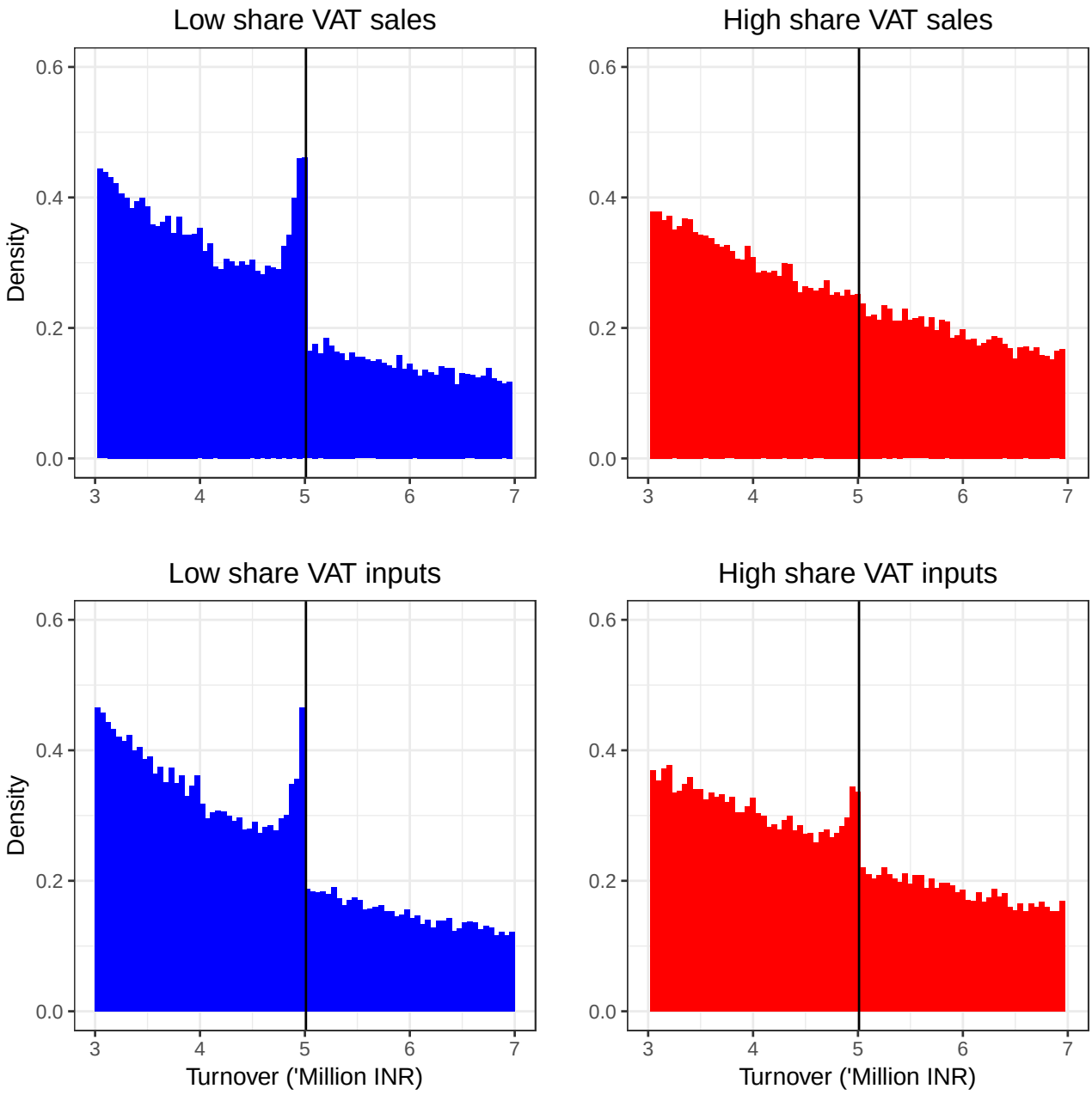
Figure 1: Trade with VAT-paying firms and tax status choice



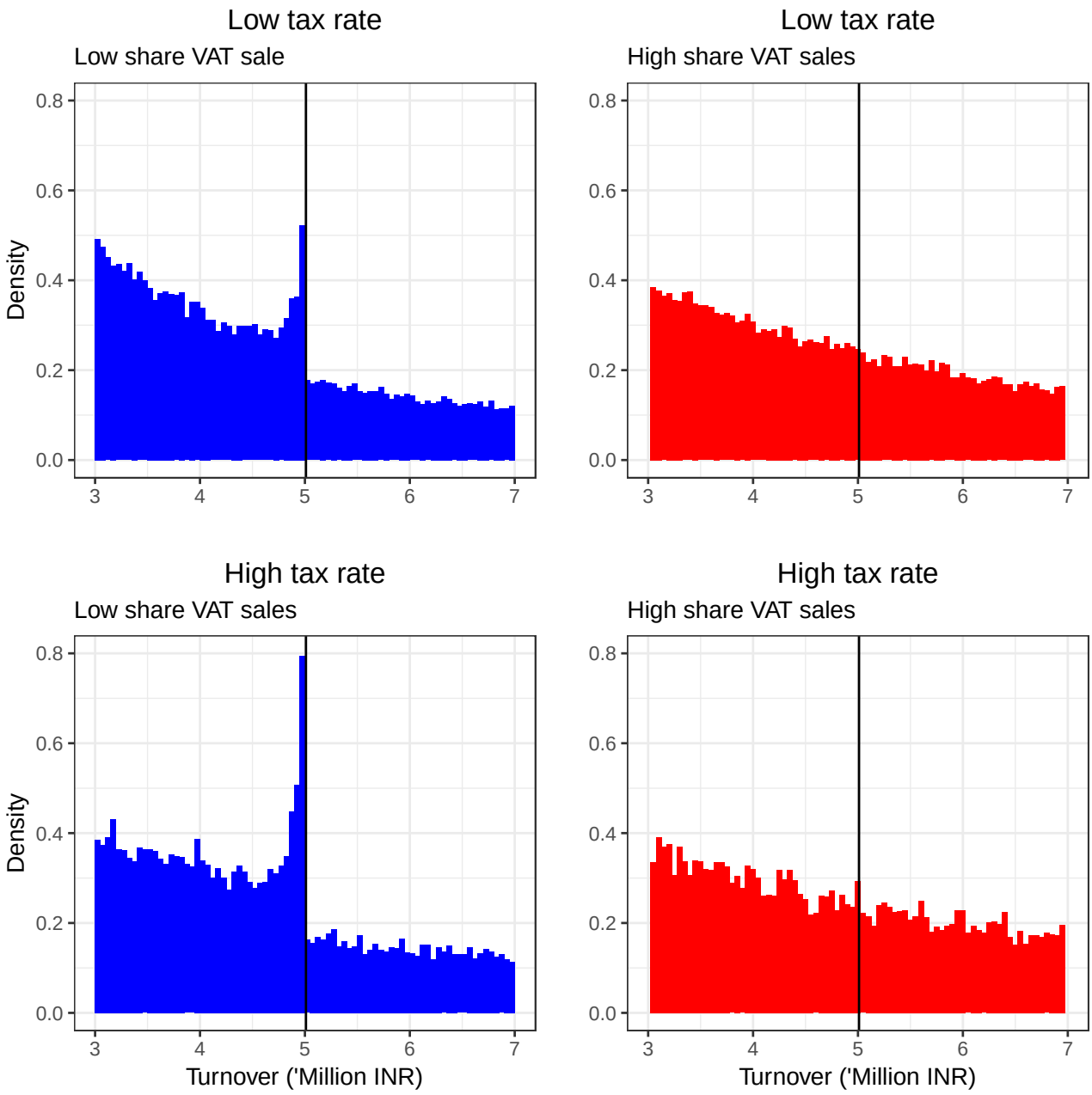
These graph plot the firm-level share of sales that are sold to VAT-paying clients (top graph) or the share of intermediate inputs purchased from VAT-paying suppliers (bottom graph) as a function of firm size. The black dots indicate VAT-paying firms, the grey triangles firms paying taxes under the simplified scheme. The vertical line indicates the size threshold above which firms have to pay VAT. We restrict the sample to firms with a turnover between 2 and 8 million INR, which represent 30% of the total sample.

Figure 2: Distribution of firm size and trade with VAT-paying firms



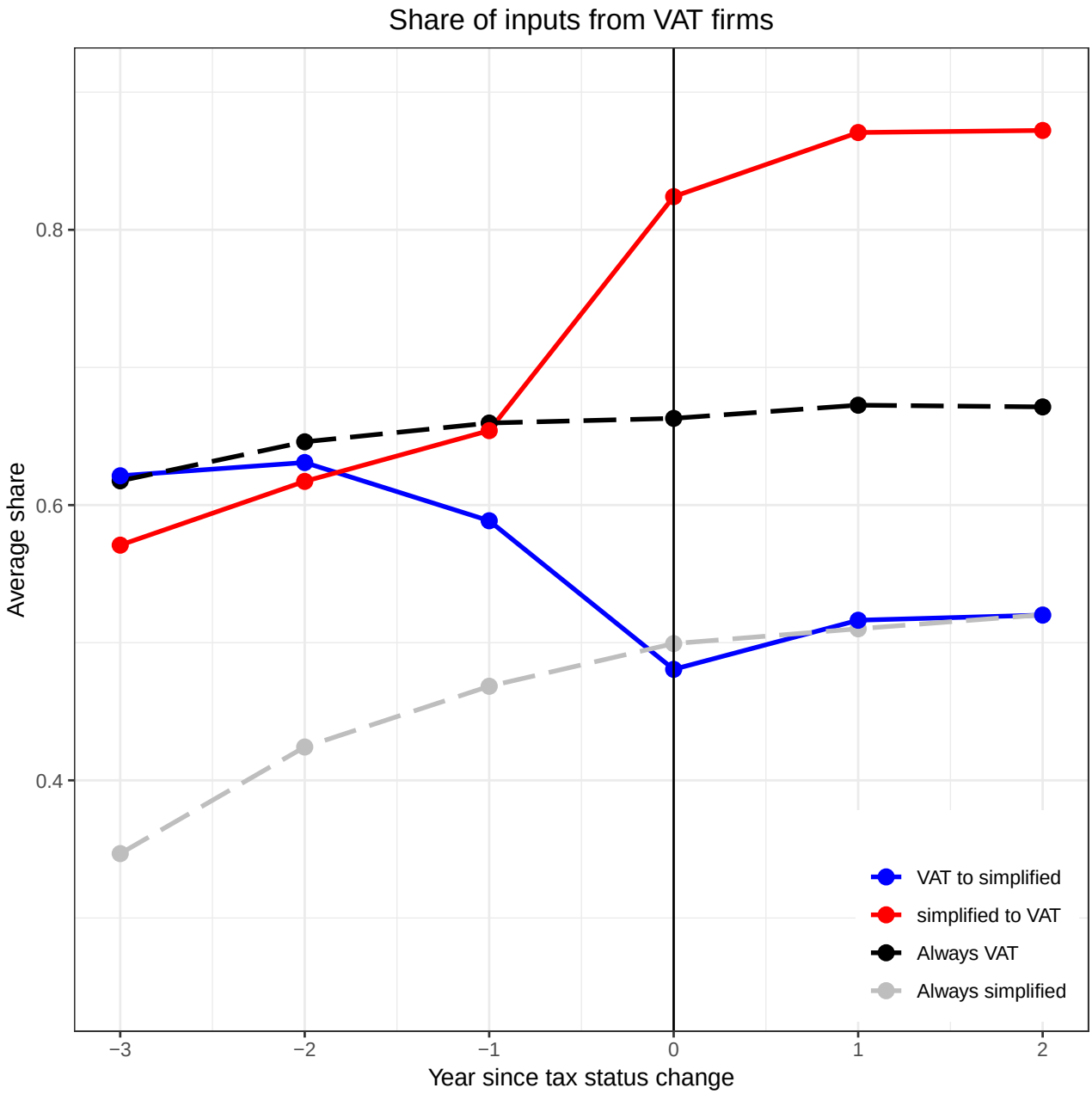
These graph plot the density distribution of firms by firm size for different sub-samples of firms with a turnover between 3 and 7 million INR. The top left (right) graph considers firms whose share of sales sold to VAT-paying clients is below (above) the sample median; the bottom left (right) graph considers firms whose share of inputs purchased from VAT-paying suppliers is below (above) the sample median. Bin sizes are 50,000 INR in all graphs.

Figure 3: Distribution of firm size and tax rate



These graph plot the density distribution of firms by firm size for different sub-samples of firms with a turnover between 3 and 7 million INR. The top two graphs considers firms that produce goods in the low and medium tax schedule, the bottom two firms that produce goods in the high tax schedule. Graphs on the left (right) include firms whose share of sales sold to VAT-paying clients is below (above) the sample median. Bin sizes are 50,000 INR in all graphs.

Figure 4: Share of inputs purchased from VAT suppliers and tax status choice



This graph plots the average share of inputs purchased from VAT suppliers over time for four groups of firms with a turnover of less than 7 million: firms that switch from the simplified to the VAT scheme (3,861 firms), firms that switch from the VAT to the simplified scheme (2,490 firms), firms that remain in the VAT scheme throughout the period (82,635 firms) and firms that remain in the simplified scheme throughout the period (10,810 firms). Each point represents an annual average, where year 0 is the year of the tax status change for firms that change tax status, and 2014 for those that do not.

Table 1: Firm-level descriptive statistics

	Simplified scheme	VAT scheme (small)	VAT scheme (large)
Turnover	1843	1591	117,133
	(1393)	(1367)	(1,321,115)
In Kolkata	0.18	0.27	0.38
Share VAT sales	0.01	0.28	0.33
	(0.07)	(0.38)	(0.36)
Share VAT inputs	0.48	0.59	0.81
	(0.42)	(0.44)	(0.33)
Has a VAT client	0.03	0.45	0.76
Has a VAT supplier	0.65	0.69	0.92
Number VAT clients	1.20	3.07	17.31
	(0.72)	(3.17)	(36.30)
Number VAT suppliers	2.73	3.63	12.56
	(2.26)	(3.61)	(19.89)
Number of firms	18,176	106,447	53,388
Observations	86,708	417,660	314,497

Mean (standard deviation). Column 1 includes all firms in the simplified tax scheme, column 2 all firms in the VAT scheme with a turnover under 5 million INR, column 3 all firms in the VAT scheme with a turnover over 5 million INR. The last two rows (number of VAT trading partners) are conditional on the firm having at least one VAT client or supplier. The variable ”share VAT sales” is the ratio of total sales to VAT firms reported in the transaction data to total sales reported by the firm in the firm data, the variable ”share VAT inputs” is the ratio of total purchases from VAT firms in the transaction data to total intermediate input purchases reported by the firm in the firm data. ”Number of VAT clients” and ”Number of VAT suppliers” are conditional on being greater than zero. Period: fiscal year 2010-2011. Turnover is in 1000 INR.

Table 2: Correlation between a firm's tax status and its use of VAT trading partners

	Outcome: In VAT scheme			
	(1)	(2)	(3)	(4)
Share VAT sales	0.229***	0.200***	0.168***	0.133***
	(0.026)	(0.027)	(0.021)	(0.019)
Share VAT inputs	0.078***	0.089***	0.084***	0.088***
	(0.017)	(0.014)	(0.014)	(0.014)
Product FE		x	x	
Location FE			x	
Product × Location FE				x
Observations	640,634	640,634	640,634	640,634

Standard errors in parentheses are clustered at the level of the good sold by the firm and the location of the firm. The dependent variable is an indicator equal to 1 if firm *i* is in the VAT scheme in year *t*, 0 if it is in the simplified tax scheme. Each column presents estimates from a regression of this indicator variable on the share of firm *i*'s sales that are sold to VAT clients and the share of firm *i*'s intermediate inputs purchased from VAT suppliers in year *t*, as well as product fixed effects (columns 2 and 3), location fixed effects (column 3) or product × location fixed effects (column 4). The sample includes all firms with a turnover of less than 7 million INR over the fiscal years 2010-2011 to 2015-2016, all specifications include year fixed effects.Significance levels: *p<0.1; **p<0.05; ***p<0.01.

Table 3: Descriptive statistics on the sample of pairs

VAT rate on transaction:	Medium tax rate	High tax rate
Pair characteristics		
Positive trade	0.611	0.551
Share of trade in client's inputs	0.122 (0.207)	0.155 (0.251)
Share of trade in supplier's sales	0.005 (0.020)	0.005 (0.018)
Client characteristics		
Number of suppliers	5.7 (9.22)	5.31 (8.57)
Turnover	3,096 (1,570)	3,077(1,041)
In VAT scheme	0.919	0.799
Number of firms	79,286	39,123
Supplier characteristics		
Number of clients	83.85 (117.03)	133.86 (226.10)
Turnover	637,238 (4,500,625)	965,276 (2,711,895)
Number of firms	21,105	6,430
Number of pairs	408,551	98,236
Number of observations	2,062,269	505,504

Mean (standard deviation). This table presents descriptive statistics on the sample of annual transactions used to estimate supply chain distortions following specification (12). There is one observation per pair$*$year as long as both firms are in our data. Turnover is in thousand INR, the variable 'Positive trade' is an indicator equal to 1 when we observe a transaction between the two firms.

Table 4: Results on supply chain distortions

	(1)	(2)	(3)	(4)	(5)	(6)
Supplier tax rate t_j:	Medium tax			High tax		
Outcome variable: Log input share s_{jkt}						
VAT client	0.138***	0.108***	0.288***	0.196***	0.167***	0.541***
	(0.015)	(0.014)	(0.038)	(0.029)	(0.028)	(0.062)
VAT client $*$ VAT input share			−0.304***			−0.589***
p. value of $\beta_1 + \beta_2 = 0$			0.584			0.126
$\rho \approx 1 + \beta(1 - t_j)/t_j$			6.5			4.8
			(0.722)			(0.434)
Supplier$*$Year FE		x	x		x	x
Observations	2,062,269	2,062,269	2,062,269	505,504	505,504	505,504

Standard errors in parentheses are two-way clustered at the level of the product sold by the client and the location of the client, standard errors for ρ are obtained using the Delta method.The sample includes all pairs that trade at least once during the period in which the supplier is never eligible to the turnover scheme (minimum turnover greater than 7 million), in columns 1 to 3 we consider pairs in which the supplier pays the medium VAT rate, in columns 4 to 6 pairs in which the supplier pays the high VAT rate. The variable 'VAT client' is equal to 1 if the client is in the VAT scheme, 0 otherwise. The variable 'VAT input share' is equal to the share of the client's intermediate inputs purchased from VAT suppliers when the client is in the simplified scheme. All specifications include pair fixed effects and control for the turnover of the client, in columns 1 and 4 we include year fixed effects and in columns 2,3, 5 and 6 year x supplier fixed effects. Significance levels: *p<0.1; **p<0.05; ***p<0.01.

Table 5: Results on strategic complementarities in tax choices

	Outcome: In VAT Scheme					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	IV	OLS	OLS	IV
Sample : turnover less than	7 million	7 million	7 million	4 million	4 million	4 million
Weighted share VAT inputs	0.616***		0.582***	0.576***		0.501***
	(0.078)		(0.179)	(0.072)		(0.172)
Weighted share VAT sales	0.207***		0.151***	0.215***		0.136**
	(0.027)		(0.056)	(0.029)		(0.059)
Predicted share VAT inputs		0.361***			0.314***	
		(0.113)			(0.109)	
Predicted share VAT sales		0.119***			0.106**	
		(0.045)			(0.049)	
Turnover control				x	x	x
Observations	640,634	640,634	640,634	571,498	571,498	571,498

Standard errors in parentheses are two-way clustered at the product and location level. The sample includes all firms with a minimum turnover over the period of less than 7 million INR in columns 1 to 3, and all firms with a minimum turnover of less than 4 million INR in columns 4 to 6. The dependent variable is an indicator equal to 1 if the firm is in the VAT scheme, 0 otherwise. The right-hand side variables 'weighted share VAT inputs' and 'weighted share VAT sales' are the variables $t_i \sum_k \lambda_{ikt} v_{kt}$ and $\sum_j t_j s_{jit} v_{jt}$: the share of the firm's intermediate inputs purchased from VAT-paying suppliers, weighted by each supplier's VAT rate, and the share of the firm's sales sold to VAT-paying clients multiplied by the firms' own VAT rates. In columns 3 and 6 these variables are instrumented for using the instruments 'predicted share VAT sales' ($t_i \sum_k \tilde{\lambda}_{ik} v_{k0} e_{kt}$) and 'predicted share VAT inputs' ($\sum_j t_j \tilde{s}_{ji} v_{j0} e_{jt}$). Sanderson and Windmeijer (2016) conditional F stats are 850.0 and 251.8 in column 3 and 930.5 and 247.7 in column 6. See the text for a description of these variables. All specifications include firm and year*x*product fixed effects, and in columns 3 to 6 the firm's turnover as an additional control. Significance levels: *p<0.1; **p<0.05; ***p<0.01. .

Table 6: Supply chain segmentation under counterfactual scenarios

	Outcome: Probability in VAT scheme				
	Observed	No trade distortions	No complementarities		Full counterfactual
	(1)	(2)	(3)	(4)	(5)
Share VAT inputs	0.088***	0.067***	0.074***	0.069***	0.049***
	(0.014)	(0.012)	(0.014)	(0.014)	(0.012)
Share VAT sales	0.133***	0.136***	0.129***	0.126***	0.128***
	(0.019)	(0.020)	(0.019)	(0.019)	(0.019)
Observations	640,634	640,634	640,634	640,634	640,634

Standard errors in parentheses are two-way clustered at the product and location level. The sample includes all firms with a minimum turnover over the period of less than 7 million INR. The right-hand side variables are the share of inputs (sales) purchased from (sold to) VAT-paying firms. In column 1 we use the observed shares, see the text for a description of how the counterfactual shares in columns 3 to 5 are constructed. All specifications include location x product and year fixed effects. Significance levels: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Online Appendix to "Taxation and Supplier Networks"

A Theory Appendix

A.1 Proof of Proposition 1

Step 1: Getting an expression of s_{jk} as a function of the no-tax-world $\tilde{s}_{jk}$
We start by: $p_{jk}q_{jk} = \alpha_{jk}^{\rho} p_{jk}^{1-\rho} P_k^{\rho} q_{kF} \phi_k^{-1}$ and by:

$$s_{jk} = \frac{p_{jk}q_{jk}}{\sum_j p_{jk}q_{jk}}$$

Note that all the terms in k that do not depend on j are going to be eliminated in the ratio. Opening up P_j and eliminating the terms that do not depend on j, we get an expression of s_{jk} that depends only on structural parameters and tax rates/statuses:

$$s_{jk} = \frac{\gamma_{jk}^{\rho-1}\phi_j^{\rho-1}\alpha_{jk}^{\rho}\alpha_{lj}^{1-\rho}}{\sum_j \gamma_{jk}^{\rho-1}\phi_j^{\rho-1}\alpha_{jk}^{\rho}\alpha_{lj}^{1-\rho}}$$

We introduce the input share $\tilde{s}_{jk}$ that prevails in the absence of taxes:

$$\tilde{s}_{jk} = \frac{\phi_j^{\rho-1}\alpha_{jk}^{\rho}\alpha_{lj}^{1-\rho}}{\sum_j \phi_j^{\rho-1}\alpha_{jk}^{\rho}\alpha_{lj}^{1-\rho}}$$

and note that:

$$s_{jk} = \frac{\gamma_{jk}^{\rho-1}\tilde{s}_{jk}}{\sum_j \gamma_{jk}^{\rho-1}\tilde{s}_{jk}}$$

Step 2: Taking the differences between $v_k = 1$ and $v_k = 0$
Under the assumption that the tax rate on simplified firms is negligible, we have $s_{jk}(1) = s_{jk}(v_k = 1) = \tilde{s}_{jk}$. The input share of a simplified client is:

$$s_{jk}(0) = \frac{\tilde{s}_{jk}(v_j(1-t_j)^{\rho-1} + (1-v_j))}{\sum_j \tilde{s}_{jk}(v_j(1-t_j)^{\rho-1} + (1-v_j))}$$

Define the share of VAT suppliers in the no-tax world when k is in the VAT regime as

$s_{Vk}(1) = \sum_j \tilde{s}_{jk} v_j$. When k is in the simplified regime, this is:

$$\begin{aligned} s_{Vk}(0) &= \frac{\sum_j \tilde{s}_{jk} v_j (1-t_j)^{\rho-1}}{\sum_j \tilde{s}_{jk}(v_j(1-t_j)^{\rho-1} + (1-v_j))} \\ &= \frac{(1-\bar{t}_k)^{\rho-1} s_{Vk}(1)}{(1-\bar{t}_k)^{\rho-1} s_{Vk}(1) + 1 - s_{Vk}(1)} \end{aligned}$$

Inverting this relationship, we can get an expression of $s_{Vk}(1)$ as a function of $s_{Vk}(0)$. Then, we get:

$$\frac{s_{Vk}(0)}{s_{Vk}(1)} = (1-\bar{t}_k)^{\rho-1} + s_{Vk}(0)[1-(1-\bar{t}_k)^{\rho-1}]$$

Now, going back to the expression of $s_{jk}(0)$, and dividing it by $s_{jk}(1) = \tilde{s}_{jk}$:

$$\frac{s_{jk}(0)}{s_{jk}(1)} = \frac{v_j(1-t_j)^{\rho-1} + (1-v_j)}{\sum_j \tilde{s}_{jk}(v_j(1-t_j)^{\rho-1} + (1-v_j))}$$

From the expression of $s_{Vk}(0)$ above, the denominator of this expression is equal to $\frac{(1-\bar{t}_k)^{\rho-1} s_{Vk}(1)}{s_{Vk}(0)}$, which can be replaced using the expression of the ratio above:

$$\frac{s_{jk}(0)}{s_{jk}(1)} = \left(v_j(1-t_j)^{\rho-1} + (1-v_j)\right)\left(1 + s_{Vk}(0)\left[\frac{1}{(1-\bar{t}_k)^{\rho-1}} - 1\right]\right)$$

Using a linear approximation valid for $t_j \ll 1$, we have:

$$\frac{s_{jk}(0)}{s_{jk}(1)} = \left(1-(\rho-1)t_j v_j\right)\left(1 + s_{Vk}(0)(\rho-1)\bar{t}_k\right)$$

Developing, subtracting 1, eliminating the second-order term, and taking the opposite:

$$\log(s_{jk}(1)) - \log(s_{jk}(0)) = (\rho-1)(t_j v_j - \bar{t}_k s_{Vk}(0)).$$

A.2 Proof of Proposition 2, part A

We start by writing the profits of upstream firm j and downstream firm k:

$$\begin{aligned} \Pi_j &= \kappa_{jF} \gamma_{jF}^{\sigma} + \sum_k \kappa_{jk} r_k^{\rho-\sigma} \gamma_{jk}^{\rho} \gamma_{kF}^{\sigma} \\ \Pi_k &= \kappa_k \frac{\gamma_{kF}^{\sigma}}{r_k^{\sigma-1}} \end{aligned}$$

with:

$$\kappa_{jF} = E\beta_j^\sigma \left(\frac{P_F}{\alpha_{\ell j} w\mu}\right)^{\sigma-1} \sigma^{-1}\phi_j^{\sigma-1}$$
$$\kappa_{jk} = P_F^{\sigma-1} E \left(\frac{\beta_k}{\mu}\right)^{\sigma} \alpha_{jk}^{\rho}(\nu P_j)^{1-\rho}\tilde{P}_k^{\rho-\sigma}\rho^{-1}\phi_j^{\rho-1}$$
$$\kappa_k = \sigma^{-1}P_F^{\sigma-1}E\beta_k^\sigma \mu^{1-\sigma}\tilde{P}_k^{1-\sigma}\phi^{\sigma-1}$$
$$r_k = \frac{P_k}{\tilde{P}_k} \approx 1 + s_{Vk}\bar{t}_k.$$

For downstream firms, we have:

$$\frac{\Pi_k^V}{\Pi_k^S} = \frac{(1-t_k)^\sigma}{(1-s_{Vk}\bar{t}_k)^{\sigma-1}}$$

For upstream firms, we define $\kappa_{jS} = \sum_k \kappa_{jk}(1-v_k)$, and $\kappa_{jV} = \sum_k \kappa_{jk} v_k$.

$$\Pi_j^V = \kappa_{jF}(1-t_j)^\sigma + \kappa_{jV}(1-\bar{t}_j)^{\sigma-1} + \kappa_{jS}\bar{r}_j^{\rho-\sigma}(1-t_j)^\rho$$
$$\Pi_j^S = \kappa_{jF} + \kappa_{jV}(1-\bar{t}_j)^{\sigma-1} + \kappa_{jS}\bar{r}_j^{\rho-\sigma}$$

Therefore:

$$\Pi_j^V - \Pi_j^S = -\kappa_{jF}[1-(1-t_j)^\sigma] - \kappa_{jS}\bar{r}_j^{\rho-\sigma}[1-(1-t_j)^\rho]$$

The first two results of the Proposition come directly out of these expressions. For the third one, we need to link the expression for the upstream firms with the share of VAT clients in the no-tax world. We have $x_{jk} = \kappa_{jk}\rho r_k^{\rho-\sigma}\gamma_{jk}^{\rho-1}\gamma_{kF}^\sigma$, so that the share of VAT clients is:

$$\lambda_{jV} = \frac{\sum_k x_{jk} v_k}{x_{jF} + \sum_k x_{jk}} = \frac{\kappa_{jV}(1-\bar{t}_j)^\sigma}{\frac{\sigma}{\rho}\kappa_{jF}(1-t_j)^{\sigma-1}\kappa_{jV}(1-\bar{t}_j)^\sigma + \kappa_{jS}\bar{r}_j^{\rho-\sigma}(1-v_j t_j)^{\rho-1}}$$

And the share of potential VAT clients is:

$$\tilde{\lambda}_{jV} = \frac{\kappa_{jV}}{\frac{\sigma}{\rho}\kappa_{jF} + \kappa_{jV} + \kappa_{jS}}$$

From there:

$$\Pi_j^V - \Pi_j^S = (\tilde{x}_{jF} + \sum_k \tilde{x}_{jk})\left[-\tilde{\lambda}_{jF}\sigma^{-1}[1-(1-t_j)^\sigma] - \tilde{\lambda}_{jS}\rho^{-1}\bar{r}_j^{\rho-\sigma}[1-(1-t_j)^\rho]\right]$$

Take the first approximation of $1-(1-t_j)^\rho$ and $1-(1-t_j)^\sigma$:

$$\Pi_j^V - \Pi_j^S = (\tilde{x}_{jF} + \sum_k \tilde{x}_{jk}) \left[-\tilde{\lambda}_{jF} t_j - \tilde{\lambda}_{jS} t_j \bar{r}_j^{\rho-\sigma} \right]$$

Consider an increase in $\tilde{\lambda}_{jV}$ that reduces either $\tilde{\lambda}_{jS}$, $\tilde{\lambda}_{jF}$, or both. For instance, consider $\frac{\partial \lambda_{jS}}{\partial \lambda_{jV}} = -\theta$ and $\frac{\partial \lambda_{jF}}{\partial \lambda_{jV}} = \theta - 1$, where $\theta \in (0,1)$. Then:

$$\frac{\partial(\Pi_j^V - \Pi_j^S)}{\partial \lambda_{jV}} = (\tilde{x}_{jF} + \sum_k \tilde{x}_{jk}) \left[(1-\theta) t_j + \theta t_j \bar{r}_j^{\rho-\sigma} \right]$$

A.3 Proof of Proposition 2, part B

Bunching occurs when the company keeps constant its sales while its productivity increases to be allowed to remain in the simplified regime. We denote $\bar{x}$ this production level, and ϕ_j^b the lowest productivity level needed to sell $\bar{x}$ for firm j. We write the profit of an upstream company j, which is bunching.

$$\Pi_j^b = \bar{x}_{jF}(1 - \frac{P_j}{\phi_j p_{jF}}) + \sum_k \bar{x}_{jk}(1 - \frac{P_j}{\phi_j p_{jk}})$$

From the expressions 7 and 8, taken for the case where j is in the simplified regime, we have: $p_{jk} = p_{jF} \mu \nu^{-1}$.

$$\Pi_j^b = \bar{x}_{jF}(1 - \frac{P_j}{\phi_j p_{jF}}) + \sum_k \bar{x}_{jk}(1 - \frac{P_j \mu}{\phi_j p_{jF} \nu})$$

$\tilde{\lambda}_{jV}, \tilde{\lambda}_{jS}, \tilde{\lambda}_{jF}$ are the share of sales that firm j makes to VAT, simplified, and final clients in the no-tax world. $\bar{x}_j(\phi_j)$ are the total sales of firm j when it has productivity ϕ_j, in a no-tax world. We have that:

$$\sum_k \bar{x}_{jk} 1\{v_k = 1\} = \tilde{\lambda}_{jV}(1-\bar{t}_j)^\sigma \bar{x}_j(\phi_j^b)$$
$$\sum_k \bar{x}_{jk} 1\{v_k = 0\} = \tilde{\lambda}_{jS} \bar{r}_j^{\rho-\sigma} \bar{x}_j(\phi_j^b)$$
$$\bar{x}_{jF} = \tilde{\lambda}_{jF} \bar{x}_j(\phi_j^b)$$

So that:

$$\Pi_j^b = \tilde{x}_j(\phi_j^b)[\tilde{\lambda}_F(1 - \frac{P_j}{\phi_j p_{jF}}) + \tilde{\lambda}_V(1 - \frac{P_j}{\phi_j p_{jF}} \frac{\mu}{\nu})(1-\bar{t}_j)^\sigma + \tilde{\lambda}_S(1 - \frac{P_j}{\phi_j p_{jF}} \frac{\mu}{\nu}) \bar{r}_j^{\rho-\sigma}]$$

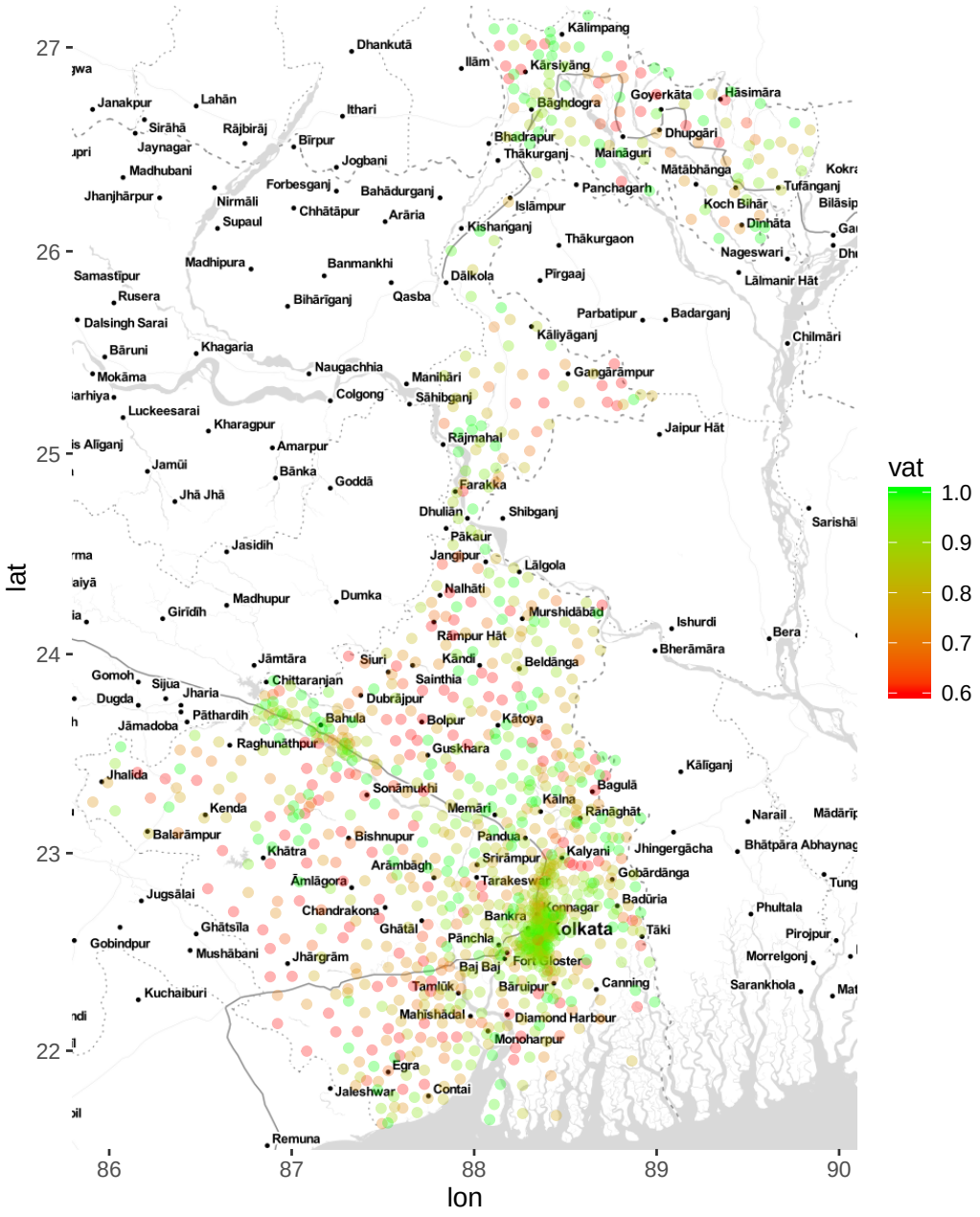
Note that: $\bar{x}_{jF} = \tilde{\lambda}_{jF}\tilde{x}_j(\phi_j^b)$, and $p_{jF} = P_F E^{\mu-1}\beta_j^{\mu} x_{jF}^{1-\mu}$, so that $p_{jF} = P_F E^{\mu-1}\beta_j^{\mu}(\tilde{\lambda}_{jF}\tilde{x}_j(\phi_j^b))^{1-\mu}$. This expression does not depend on ϕ_j or any parameter of the tax system. p_{jF} will decrease when $\tilde{\lambda}_{jF}$ increases.

B Additional Tables and Figures

B.1 Context and data section

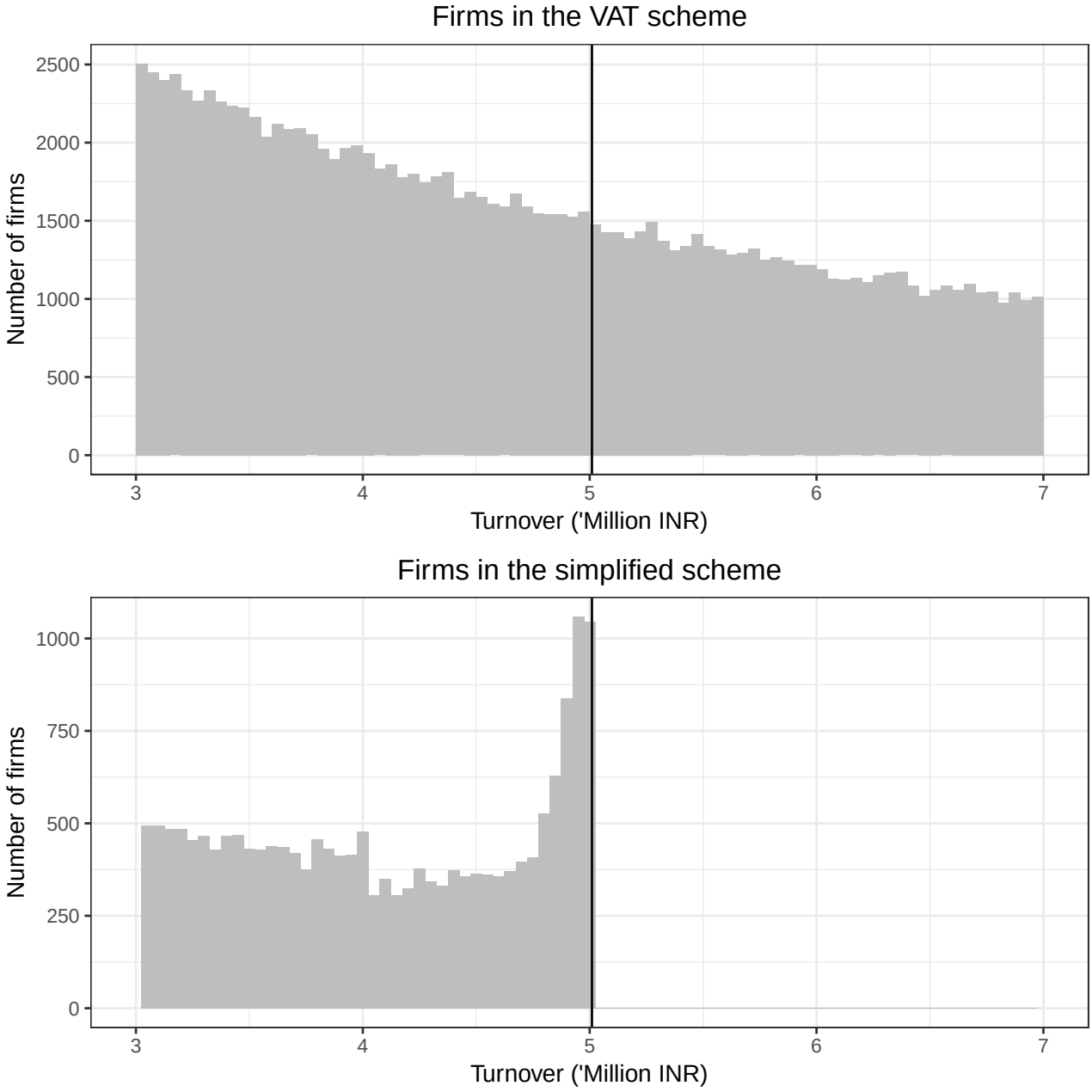
Figure B.2 plots the distribution of firms around the 5 million INR sales threshold above which firms have to pay taxes under the VAT scheme. Figure B.1 plots the location of firms in our data on a map of West Bengal. Each dot represents a postcode, the color of the dot indicates the share of firms in that postcode that are in the VAT scheme. Table B.1 presents the types of products sold by firms as well as the average size and the share of VAT-paying firms among firms selling each product.

Figure B.1: Share of firms in the VAT scheme by location



Each dot represents a postcode in which firms in our data are located, the color of the dot represents the share of firms in the postcode that pay taxes under the VAT scheme. The dotted lines are state borders.

Figure B.2: Distribution of firms around the simplified tax threshold



This graph plots the density distribution of firms by turnover size around the 5 million INR threshold above which firms can no longer opt to be in the simplified tax scheme. This threshold is indicated by the black vertical lines. The top graph plots the distribution for firms paying taxes under the VAT scheme, the bottom graph the distribution for firms paying taxes under the simplified scheme.

Table B.1: Products sold and firm tax status in 2010-2011

Commodity type	Turnover	% Large firms	Amongst small, % VAT	Nb firms
Machines & equipment	28,285 (422,356)	32.05	91.32	19510
Construction materials	12,137 (153,641)	24.69	79.19	16911
Electrical & electronic goods	33,474 (833,588)	33.62	81.21	15560
Food, drink & tobacco	40,277 (531,480)	40.82	73.61	14828
Chemical products	41,336 (977,889)	37.05	76.09	11107
Textiles	24,235 (170,384)	31.61	72.03	10969
Metal products	109,361 (781,319)	54.46	94.07	10739
Wood & paper	20,826 (140,983)	29.00	90.6	9417
Other commodities	60,963 (1,097,142)	27.57	88.78	8479
Rubber & plastic	44,919 (1,095,713)	34.48	87.42	4672
Household goods	9,656 (90,727)	17.86	77.06	3444
Mining & energy	72,134 (1,042,568)	52.29	89.95	2689
All	38,376 (657,094)	34.17	82.72	128325

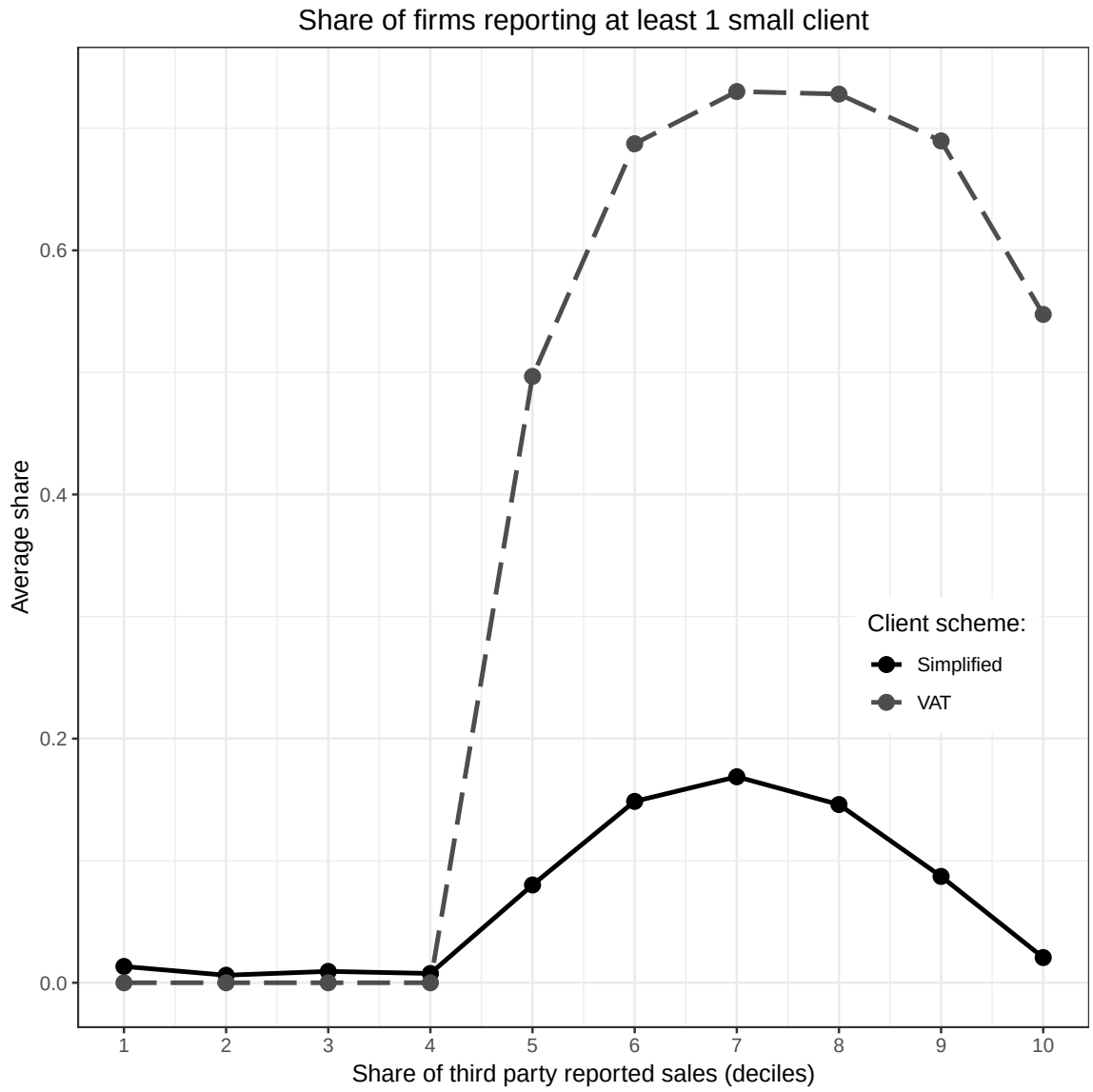
This table presents descriptive statistics by type of main product sold by firms, where we have classified over 170 different product types into 13 large product categories. The first column presents the share of firms with a turnover of over 5 million INR, the second column the share of VAT firms amongst firms with a turnover of less than 5 million INR and the third column the total number of firms in that category in 2010-2011. Categories are ranked from the one with the largest number of firms (Machines & equipment) to the one with the lowest number of firms (Mining & energy) in 2010-2011.

B.2 Additional evidence on asymmetric under-reporting of transactions

Figure B.3 and Table B.2 present additional evidence that helps assess whether VAT-paying firms are less likely to report transactions with clients in the simplified scheme than transactions with clients in the VAT scheme. We define a sale as 'third-party-reported' if both the seller and the buyer involved in the transaction report the sale, ie both pay VAT. Table B.2 shows that firms report total sales that are on average three times large than their total third-party-reported sales. The share of third-party-reported sales among total sales is larger for firms which report at least one transaction with a client in the simplified scheme (a non third-party-reported sale) than for those with no reported client in the simplified scheme. This is the opposite of what we'd see if firms were only willing to report sales to clients in the simplified scheme if reporting this transaction has no impact on their total sales.

Figure B.3 plots the average share of firms reporting at least one client with a turnover of less than 7 million INR for each decile of the share of third-party-reported sales. Firms in the first four deciles have no third-party reported sales. The black full line plots the share of firms reporting at least one client in the simplified scheme, the grey dashed line plots the share of firms reporting at least one small client in the VAT scheme. If firms were only willing to report sales to clients in the simplified scheme if reporting this transaction has no impact on their total sales we would see a steep decline in the share of firms with clients in the simplified scheme as the share of third-party-reported sales increases, but no decline in the share of firms with a small VAT-paying client (as transactions with small VAT-paying clients are also reported by the client). We see that this is not the case: firms with high shares of third-party-reported sales are less likely to report trading with small clients, regardless of the tax status of the client.

Figure B.3: Sales to simplified scheme clients as a function of third party reported sales



This graph plots the share of firms trading with at least one client with a turnover of less than 5 million INR for each decile of the distribution of the share of firms' sales that are third party reported. The dashed line plots the share of firms trading with at least one client in the VAT scheme, the unbroken line the share of firms trading with at least one client in the simplified scheme. 40% of firms have no third-party reported sales so the share of firms with a VAT client is zero by definition for the first four deciles.

Table B.2: Share of third-party-reported sales and sales to simplified scheme clients

	Share of third-party-reported sales	Observations
All firms	0.30 (0.38)	732,114
Of which		
Positive sales to simplified scheme clients	0.38 (0.30)	50,358
No sales to simplified scheme clients	0.29 (0.28)	681,756

The sample includes all firms in the VAT scheme in the first line, only VAT firms with positive sales to clients in the simplified scheme in the second line, and all remaing VAT firms in the last line. We define 'third-party-reported sales' as sales to clients in the VAT scheme, and report the share of these sales in the total sales of the firm.

B.3 Empirical strategy section

Table B.3 presents descriptive statistics on the variables and the sample used to estimate strategic complementarities.

Table B.3: Descriptive statistics, strategic complementarities sample

	Always VAT scheme	Always simpl. scheme	Switchers
Right-hand-side variables:			
Turnover	4077 (6337)	1745 (1322)	3564 (4844)
Weighted share VAT inputs	0.033 (0.031)	0.031 (0.037)	0.047 (0.041)
Weighted share VAT sales	0.013 (0.019)	0.001 (0.005)	0.002 (0.009)
Predicted share VAT inputs	0.036 (0.028)	0.035 (0.033)	0.051 (0.035)
Predicted share VAT sales	0.016 (0.019)	0.001 (0.004)	(0.002) (0.009)
Trading partners:			
Has a trading partner	0.92	0.80	0.92
Nb trading partners	16.9 (21.8)	5.3 (4.9)	9.2 (9.8)
Has an enter./exiting partner	0.67	0.34	0.54
Nb enter./exiting partners	4.6 (5.5)	1.8 (1.2)	2.7 (2.6)
Trading partner's turnover	400,289 (575,501)	481,510 (653,791)	563,548 (648,470)
Enter./exiting partner's turnover	129,825 (287,608)	158,574 (394,523)	200,645 (460,281)
Number of firms	121,690	13,576	7,648
Observations	535,198	66,779	38,657

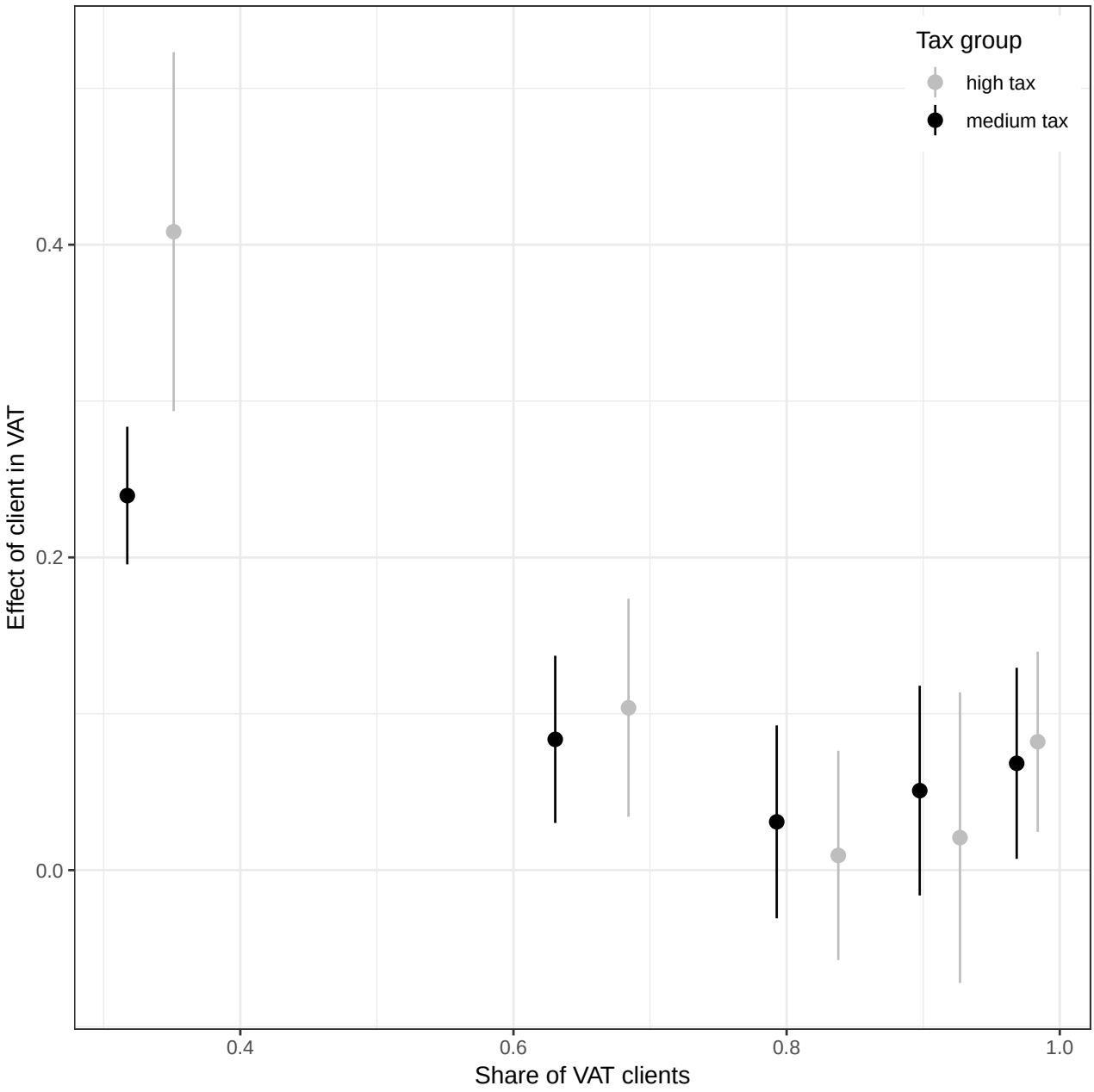
Mean (standard deviation). This table presents descriptive statistics on the sample of firms used to estimate strategic complementarities in (13). Turnover is in thousand INR, the variables ' weighted share VAT inputs', 'weighted share VAT sales', 'predicted share VAT inputs' and 'predicted share VAT sales' are defined in the text. The variable 'has a trading partner' ('has an entering/exiting partner') are equal to 1 if the firm has at least one supplier or client over the period (at least one supplier or client that enters or exit over the period). The variables 'Nb trading partners' and 'Nb entering/exiting partners' are conditional on the firm having at least one partner. The last two lines present the average turnover of the firm's trading partners. The sample in the first column includes all firms that are always in the VAT scheme, in the second column all firms always in the simplified scheme, and in the third column all firms that change tax scheme over the period.

B.4 Results section

Tables B.5 and B.4 present estimates of supply chain distortions obtained on alternative samples or using alternative specifications. Figure B.4 plots the estimated coefficients obtained by running specification (12) on sub-samples of pairs. We split the sample by quintile of the distribution of s_{Vk}, the VAT share of firms' intermediate inputs. We see that the effect is decreasing with how much the client buys from VAT suppliers when in the simplified scheme in both sub-samples. The estimates obtained on sub-samples in which the client's VAT input share is very close to one are not equal to zero, which may be due to the fact that we do not observe labor input costs. Labor costs are non VAT-deductible, so labor's cost increases relative to that of inputs purchased from VAT suppliers when clients enter the VAT scheme. Our model's logic implies that firms that buy a large share of their inputs from VAT-paying suppliers when they are in the simplified scheme (those to the left of the x-axis scale in Figure B.4) may therefore substitute away from labor when they enter the VAT scheme and buy even more inputs from VAT-paying suppliers. Our estimates are in line with this conjecture.

Table B.6 presents first stage results for our estimation of strategic complementarities and Table B.7 additional estimates of strategic complementarities obtained on alternative samples or using alternative specifications. Finally Table B.8 presents unconditional correlations between firms' propensity of being in the VAT scheme and their trade with VAT-paying firms under different counterfactual scenarios.

Figure B.4: Supply chain distortions, results by quintile of VAT input share



This graph plots the estimated coefficients obtained by running specification (12) on sub-samples of pairs. We split the sample by quintile of the distribution of s_{Vk}, the VAT share of firms' intermediate inputs. Each point represents an estimate obtained on a sub-sample among pairs in which the supplier pay the high tax rate in black, and pairs in which the supplier pay the medium tax rate in grey. The location on the x-axis corresponds to the average VAT share of inputs in the sub-sample. Bars represent the 95% confidence intervals.

Table B.4: Additional results on supply chain distortions - robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)
Supplier tax rate t_j:	Medium tax			High tax		
Panel A. Excluding suppliers with large shares of third-party reported sales						
VAT client	0.138***	0.113***	0.289***	0.183***	0.147***	0.494***
	(0.015)	(0.013)	(0.038)	(0.028)	(0.025)	(0.062)
VAT client $*$ VAT input share			−0.300***			−0.554***
			(0.060)			(0.067)
p. value of $\beta_1 + \beta_2 = 0$			0.698			0.076
$\rho \approx 1 + \beta(1 - t_j)/t_j$			6.491			4.458
			(0.722)			(0.434)
Supplier$*$Year FE		x	x		x	x
Observations	1,558,605	1,558,605	1,558,605	438,607	438,607	438,607
Panel B. Adding year x location fixed effects						
VAT client	0.133***	0.107***	0.288***	0.188***	0.165***	0.542***
	(0.014)	(0.014)	(0.038)	(0.030)	(0.028)	(0.062)
VAT client $*$ VAT input share			−0.306***			−0.594***
			(0.058)			(0.067)
p. value of $\beta_1 + \beta_2 = 0$			0.492			0.096
$\rho \approx 1 + \beta(1 - t_j)/t_j$			6.472			4.794
			(0.722)			(0.434)
Supplier$*$Year FE		x	x		x	x
Observations	2,062,269	2,062,269	2,062,269	505,504	505,504	505,504
Panel C. Outcome variable: Trade > 0						
VAT client	0.138***	0.111***	0.264***	0.139***	0.126***	0.328***
	(0.007)	(0.006)	(0.010)	(0.009)	(0.008)	(0.015)
VAT client $*$ VAT input share			−0.258***			−0.318***
			(0.014)			(0.018)
p. value of $\beta_1 + \beta_2 = 0$			0.467			0.262
Supplier$*$Year FE		x	x		x	x
Observations	6,347,650	6,347,650	6,347,650	1,220,529		

The dependent variable is the log input share s_{jkt} in Panels A and C and an indicator equal to 1 if the two firms trade in panel C. The sample in panel A excludes pairs in which the supplier sells more than 90% of its sales to other firms, the sample in panels B and C is the sample used in our baseline specification in Table 4. All specifications include pair fixed effects and control for the log turnover of the client firm k, in columns 1 and 3 we include year fixed effects and in columns 2 and 4 year x supplier fixed effects. In Panel C we also include location x year fixed effects. Standard errors in parentheses are two-way clustered at the level of the product sold by and the location of the client. Significance levels: *p<0.1; **p<0.05; ***p<0.01

Table B.5: Additional results on supply chain distortions - alternative samples

	(1)	(2)	(3)	(4)	(5)	(6)
Supplier tax rate t_j:	Medium tax			High tax		
Panel A. Including all clients eligible to the simplified scheme						
VAT client	0.154***	0.118***	0.301***	0.220***	0.188***	0.577***
	(0.014)	(0.013)	(0.035)	(0.029)	(0.027)	(0.068)
VAT client $*$ VAT input share			−0.304***			−0.612***
			(0.054)			(0.071)
p. value of $\beta_1 + \beta_2 = 0$			0.909			0.131
$\rho \approx 1 + \beta(1 - t_j)/t_j$			6.719			5.039
			(0.665)			(0.476)
Supplier$*$Year FE		x	x		x	x
Observations	2,680,746	2,680,746	2,680,746	639,931	639,931	639,931
Panel B. Restricting to very large suppliers						
VAT client	0.137***	0.108***	0.292***	0.199***	0.173***	0.568***
	(0.015)	(0.014)	(0.040)	(0.029)	(0.028)	(0.063)
VAT client $*$ VAT input share			−0.306***			−0.619***
			(0.063)			(0.065)
p. value of $\beta_1 + \beta_2 = 0$			0.627			0.101
$\rho \approx 1 + \beta(1 - t_j)/t_j$			6.548			4.976
			(0.760)			(0.441)
Supplier$*$Year FE		x	x		x	x
Observations	1,853,960	1,853,960	1,853,960	469,232	469,232	469,232
$\rho \approx 1 + \beta(1 - t_j)/t_j$		7		4.9		

The dependent variable is the log input share s_{jkt}. Relative to the sample used in our baseline specification in Table 4 the sample in panel A includes all pairs in which the client has a (minimum) turnover of less than 7 million INR, in panel B the sample includes all pairs in which the supplier has a (minimum) turnover larger than 10 million INR.All specifications include pair fixed effects and control for the log turnover of the client firm k, in columns 1 and 3 we include year fixed effects and in columns 2 and 4 year x supplier fixed effects.Standard errors in parentheses are two-way clustered at the level of the product sold by and the location of the client. Significance levels: *p<0.1; **p<0.05; ***p<0.01

Table B.6: Strategic complementarities: first stage results

	Outcome: In VAT Scheme			
	(1)	(2)	(3)	(4)
Outcome variable:	Share VAT inputs	Share VAT sales	Share VAT inputs	Share VAT sales
Turnover less than	7 million	7 million	4 million	4 million
Pred. share VAT inputs	0.618***	0.010*	0.629***	0.010
	(0.025)	(0.006)	(0.024)	(0.006)
Pred. share VAT sales	−0.003	0.799***	0.001	0.800***
	(0.015)	(0.018)	(0.016)	(0.018)
Turnover control			x	x
Observations	640,634	640,634	571,498	571,498

Standard errors in parentheses are two-way clustered at the product and location level. This table presents the first stage results corresponding to the second stage in Table 5, columns 3 and 6. The sample includes all firms with a minimum turnover over the period of less than 7 million INR in columns 1 and 2, and all firms with a minimum turnover of less than 4 million INR in columns 3 and 4. The dependent variable is an indicator equal to 1 if the firm is in the VAT scheme, 0 otherwise. The outcome variables 'share VAT inputs' and 'share VAT sales' are the variables $t_i \sum_k \lambda_{ikt} v_{kt}$ and $\sum_j t_j s_{jit} v_{jt}$, the right-hand-side variables are 'predicted share VAT sales' ($t_i \sum_k \tilde{\lambda_{ik}} v_{k0} e_{kt}$) and 'predicted share VAT inputs' ($\sum_j t_j \tilde{s_{ji}} v_{j0} e_{jt}$). See the text for a description of these variables. All specifications include firm and year*x*product fixed effects, and in columns 3 and 4 the firm's turnover as an additional control. Significance levels: *p<0.1; **p<0.05; ***p<0.01. .

Table B.7: Additional results on strategic complementarities

	Outcome: In VAT Scheme					
	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) OLS	(6) IV
A. Lowering sample thresholds						
Weighted share VAT inputs	0.622***		0.591***	0.570***		0.498***
	(0.078)		(0.046)	(0.071)		(0.171)
Weighted share VAT sales	0.209***		0.154***	0.216***		0.163***
	(0.028)		(0.057)	(0.027)		(0.061)
Predicted share VAT inputs		0.369***			0.314***	
		(0.116)			(0.109)	
Predicted share VAT sales		0.121***			0.128***	
		(0.046)			(0.050)	
Turnover control				x	x	x
Observations	623,990	623,990	623,990	551,738	551,738	551,738
B. Increasing sample thresholds						
Weighted share VAT inputs	0.611***		0.581***	0.588***		0.535***
	(0.077)		(0.181)	(0.073)		(0.181)
Weighted share VAT sales	0.204***		0.147***	0.214***		0.123**
	(0.027)		(0.055)	(0.027)		(0.059)
Predicted share VAT inputs		0.360***			0.335***	
		(0.114)			(0.115)	
Predicted share VAT sales		0.115***			0.096**	
		(0.044)			(0.048)	
Turnover control				x	x	x
Observations	654,851	654,851	654,851	587,610	587,610	587,610
C. With yearxlocation fixed effects						
Weighted share VAT inputs	0.593***		0.526***	0.573***		0.492***
	(0.075)		(0.167)	(0.071)		(0.169)
Weighted share VAT sales	0.207***		0.174**	0.216***		0.138*
	(0.028)		(0.071)	(0.028)		(0.072)
Predicted share VAT inputs		0.324***			0.306***	
		(0.103)			(0.106)	
Predicted share VAT sales		0.140**			0.111*	
		(0.057)			(0.058)	
Turnover control				x	x	x
Observations	640,634	640,634	640,634	571,498	571,498	571,498

Standard errors in parentheses are two-way clustered at the product and location level. The sample in panels A, B and C include all firms with a minimum turnover over the period of less than 6,8 and 7 million INR in columns 1 to 3, and all firms with a minimum turnover of less than 3, 4.5 and 4 million INR in columns 4 to 6. The dependent variable is an indicator equal to 1 if the firm is in the VAT scheme, 0 otherwise. The right-hand side variables 'weighted share VAT inputs' and 'weighted share VAT sales' are the variables $t_i \sum_k \lambda_{ikt} v_{kt}$ and $\sum_j t_j s_{jit} v_{jt}$, in columns 3 and 6 these variables are instrumented for using the instruments 'predicted share VAT sales' ($t_i \sum_k \tilde{\lambda_{ik}} v_{k0} e_{kt}$) and 'predicted share VAT inputs' ($\sum_j t_j \tilde{s_{ji}} v_{j0} e_{jt}$). All specifications include firm and year*x*product fixed effects, and in columns 3 to 6 the firm's turnover as an additional control. Significance levels: *p<0.1; **p<0.05; ***p<0.01. .

Table B.8: Supply chain segmentation under counterfactual scenarios, no location×product fixed effects

	Outcome: Probability in VAT scheme				
	Observed	No trade distortions	No complementarities		Full counterfactual
	(1)	(2)	(3)	(4)	(5)
Share VAT inputs	0.078***	0.056***	0.062***	0.058***	0.036**
	(0.017)	(0.015)	(0.017)	(0.017)	(0.015)
Share VAT sales	0.229***	0.232***	0.228***	0.224***	0.226***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Observations	640,634	640,634	640,634	640,634	640,634

Standard errors in parentheses are two-way clustered at the product and location level. The sample includes all firms with a minimum turnover over the period of less than 7 million INR. The right-hand side variables are the share of inputs (sales) purchased from (sold to) VAT-paying firms. In column 1 we use the observed shares, see the text for a description of how the counterfactual shares in columns 3 to 5 are constructed. All specifications include year fixed effects. Significance levels: *p<0.1; **p<0.05; ***p<0.01.